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This memorial to Alexander Lyman Holley . . .

. . . dedicated in 1890, stands in Washington Square Park at the foot of Fifth Avenue, New York, N. Y. Holley, one of the pioneers of American engineering, was a Founder and Honorary Member in Perpetuity of ASME. The column which supports the bronze bust is inscribed: "To Alexander Lyman Holley, foremost among those whose genius and energy established in America and improved throughout the world the manufacture of Bessemer steel, this memorial is erected by engineers of two hemispheres."

Editorial

MECHANICAL ENGINEERING

February, 1955, Vol. 77, No. 2 ◆ George A. Stetson, *Editor*

The Engineer's Communications

On February 16 The American Society of Mechanical Engineers will hold the first of a series of meetings in commemoration of its 75th Anniversary. It is appropriate to hold this meeting in New York where the *American Machinist* is located because it was in the offices of that magazine that the preliminary organization meeting took place on Feb. 16, 1880.

At that meeting Alexander Lyman Holley "delivered an earnest and pointed address" in which he asked his fellow engineers to consider "the advantage and character of our proposed organization," and stressed ways in which the engineer might communicate with his colleagues. Thus the topic chosen for discussion at the 1955 anniversary of the *American Machinist* preliminary meeting, "The Engineer and the World of Communication," is both appropriate and significant.

What were the three means of communication stressed by Mr. Holley?

"First. The most obvious advantage," said Mr. Holley, "is the collection and diffusion of definite and much needed information by means of papers and discussions.

"Second. A less obvious, but. . . .a more important advantage of organization is the general, personal acquaintance thus promoted. . . .

"Third. The habit of writing and discussing technical papers is of very great importance."

Mr. Holley then clearly pointed out "the advantages of the association of business men with engineers" in the Society as including not only large membership "and hence large incomes to devote to publications and illustrations," but lying also "chiefly in the direct business results of bringing professional knowledge, capital, and business talent together under the most favorable circumstances."

"Meetings should not be too infrequent," he stated, and should be held "in different parts of the country, which give distant members home facilities from time to time, and keep up the Society interest."

How closely ASME followed the wise precepts set forth by Mr. Holley is reflected in the history of the Society for the past seventy-five years. The Council report for 1953–1954 shows that 11 national Society meetings and division conferences were held, with a total of 253 sessions and 606 technical papers, and if one were to include all Section and Student Branch meetings, the number of meetings would approximate 1000. Moreover, the financial report shows more than a million dollars spent on publications. And if anyone were to estimate the number of personal contacts afforded by these meetings he would arrive at a staggering total.

Today, with engineering as important to the national defense and economy as it is, engineers are even more closely allied with businessmen than they were in Mr. Holley's day, while the number of members interested directly in business as well as technical matters is well known and revealed by the size and activity of the Management Division. Surely the Society has steadily developed and expanded the means of communication that bring engineers more closely together, affords opportunity for working on hundreds of committees where personal contacts bear the fruit of friendship and increased knowledge of men and affairs, and provides outlets for the writing of papers, for their discussion, and for their publication.

In contrast with 1880, the situation today in respect to the dissemination of information and the opportunities for personal contacts between engineers has vastly changed. Where there were then few books, magazines, and libraries devoted to engineering, today the number is overwhelming. New means of rapid communication and travel, new methods of reproducing and preserving technical papers, new schemes for indexing, reviewing, and digesting rapidly accumulating knowledge of engineering and scientific subject matter, the enrichment of technology by application of advances made in the sciences, the growth of special libraries and research organizations, the rapid growth of, and obsolescence in, all productive industries, and the importance of these factors in the economy of the nation and to social changes create new problems based on abundance, rather than lack of useful information. To engineering societies whose principal task it is to stimulate and disseminate technical information, the problem of the means by which this objective may be attained, and the expense of, and easy access to, the enormous accumulation of this material, are important and difficult problems.

What the future will bring in the way of solutions to these problems no one can fully predict. But it can be assumed that the Society must work out solutions if it is to continue to follow the pattern set for it by its Founders and is to develop those means of communication of information which have served, and will always serve, the best interest of its members.

A Reactor Emergency

. . . with resulting improvements

By G. W. Hatfield

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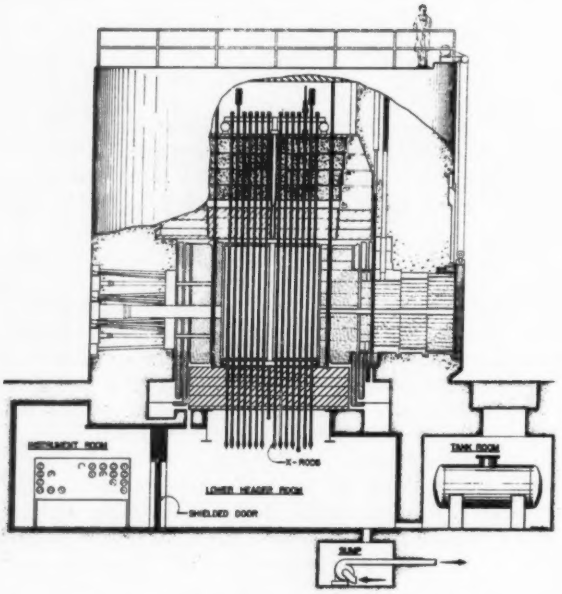

Fig. 1 Cross section of the NRX reactor which had been in operation for five years when a mechanical failure caused a near-disastrous emergency

On December 12, 1952, a low-power experiment was being carried out in Canada's NRX nuclear reactor which had been operating for 5 years. Owing to a complex chain of events, a mechanical failure occurred in the shutoff-rod system which resulted in a power surge. About 10 per cent of the uranium rods in the reactor had temporary connections made to them to permit a reduced flow of cooling water for experimental purposes and the overheating resulting from the power surge caused the reduced flow of water to boil to the extent that some of the uranium and aluminum melted. Breaks occurred in some of the calandria tubes as well as uranium sheaths and water tubes on the uranium rods, thereby permitting cooling water to flow into the basement beneath the pile. Thus some uranium metal became exposed to the cooling water and fission products were leached out into the water flooding the basement.

The NRX Reactor

Fig. 1 represents a cross section of the NRX Reactor. Starting at the top, is shown a revolving steel plate used for the removal of rods, the top cooling-water header, the four concrete biological shields, and below that the three steel water-cooled thermal shields. The aluminum vessel in the center is approximately 8 ft diam and 10 ft high with tubes rolled into the tube sheet at the top and bottom similar to a calandria used for heating in a vacuum pan. This vessel contains the heavy water which is used as a moderator. Below the aluminum tank are four water-cooled steel thermal shields followed by a lead-masonite shield and bottom outlet cooling-water header. The rods are approximately 31 ft in over-all length with 10-ft uranium sections that pass through the tubes in the heavy-water area of the aluminum tank. The aluminum tank is surrounded with graphite which acts as a neutron reflector and steel shields surround the graphite with approximately 8 ft of concrete as a biological shield beyond the steel shields.

At the time of the accident the cooling water flooded into the basement at the rate of 300 gpm, at one stage rising to a level halfway up the instrument-panel board.

Fig. 2 represents a uranium-rod assembly inserted in the reactor. It is to be noted that air passes up through the calandria tube around the water sheath of the uranium rod, which air removes a small portion of the heat generated. Fission products which escaped into this air stream were negligible at the time of the accident, being mostly of a short life.

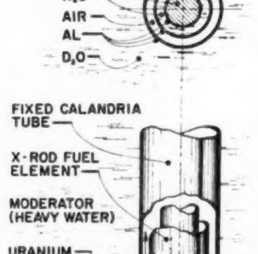

Fig. 2 Uranium-rod assembly inserted in reactor

Emergency Measures

Fig. 3 indicates the problem which faced the staff and represents two different examples of ruptured rods where cooling water in contact with bare uranium was flooded into the basement. It was not considered safe to shut off this flow of cooling water as the condition of the uranium was not known. The main concern was the

Contributed by the Safety Division and presented at a joint session of the Safety Division, Nuclear Energy Application Committee, and Power Division at the Annual Meeting, New York, N. Y., November 28–December 3, 1954, of The American Society of Mechanical Engineers. (Condensed slightly from ASME paper 54—A-224.)

fact that some of this uranium was highly irradiated and, if this uranium were not cooled, it would heat up to the point where the metal would oxidize rapidly and even catch fire. Therefore, as the first precaution, the cooling water to all the rods in the reactor was decreased to a minimum by gradually throttling the flow of water through the valves leading to the main header. In this manner the flooding of the basement was decreased from 300 to 60 gpm. This was followed later with shutting off the cooling water to the rods which were not ruptured after installing special headers as shown in Fig. 3. Here, needle valves were used to control the flow at the top and bottom of each ruptured rod. After this installation was completed the leak to the basement was decreased to 14 gpm.

At the same time, while we were endeavoring to decrease the flooding below the reactor, the active water which already had collected in the basement was being pumped to large storage tanks outside the main building and these tanks were rapidly becoming filled to capacity. A decision was made 5 days after the accident to pump this active water out to the disposal area where the soil was a mixture of sand and clay. In zero weather a pipe line $1^1/_4$ miles long with the necessary pumping facilities was installed in the next 5-day period. Approximately 1,000,000 gal of active water containing 10,000 curies of long-lived fission products were pumped through this pipe line to the disposal area. (For comparison, some 1500 curies of radium have been produced in the world to date.) A check was kept on the activity in the water draining from the disposal area and no detectable activity has been found even in the creek draining the area to a small lake.

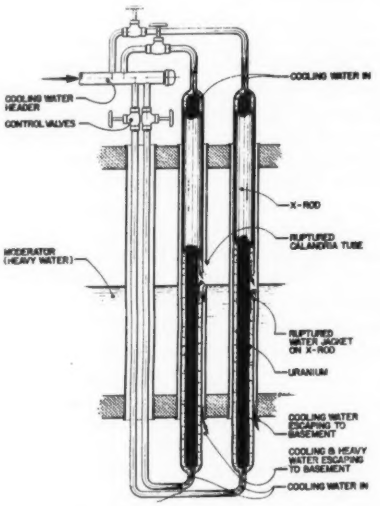

Fig. 3 Two different examples of ruptured rods which were involved in the accident

Dismantling the Reactor

It is difficult to describe the multitude of problems associated with radioactivity with which we were faced during the next 8-month period when dismantling the reactor. These problems included the design and fabrication of many special tools for use by remote control for cutting and removing the ruptured rods out of the reactor as well as the removal of the stainless-steel water headers and valves below the reactor which were badly contaminated, and the decontamination of thousands of square feet of concrete throughout the reactor building.

Removing the Aluminum Calandria. The procedure used for removing the aluminum calandria from the reactor will be described. This calandria is probably the largest radioactive source that has been handled to date.

Owing to this high level of radioactivity, all operations had to be controlled remotely.

In Fig. 4 a lifting jig was first lowered down on top of the calandria. This jig had dogs hanging below, designed in such a way that when the dogs entered the holes through the calandria tube sheet, they slipped outward hooking onto the underside of the sheet when a lifting strain was applied to the jig. The overhead crane hook was lowered and engaged by remote control to the hook on the lifting jig. The calandria was then raised out of the hole and, with the use of long ropes as guides, it was moved across the pile by the crane and lowered into a canvas bag which was attached to a skid turned up on one end against the side of the reactor.

The skid was then lowered into a horizontal position on the floor of the reactor building by slackening off on a yoke which was attached from the outer face of the skid to the inner face of the reactor and thence out to a bulldozer which acted as a winch. After the skid was in a horizontal position on the floor, the pin was withdrawn from the outer end of the skid by means of a long rope attached. This released the skid from the yoke.

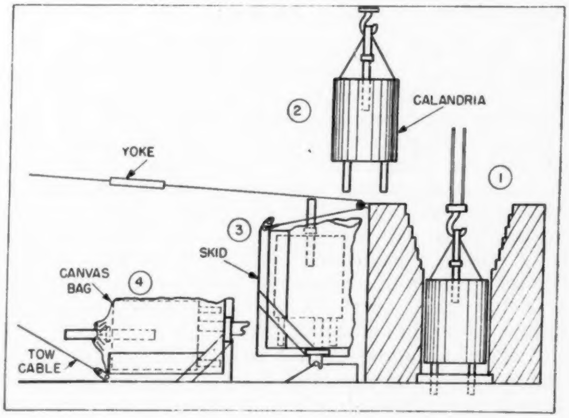

Fig. 4 Method of handling contaminated calandria tank, illustrating its removal to the disposal area

The skid was then towed out of the reactor building, with all remaining ropes attached, with the use of a grader, through the plant proper to the disposal area about $1^1/_2$ miles away.

Radiation Measurements. Radiation measurements on this tank indicated 20 roentgens per hr in contact with the top tube sheet, 100 roentgens per hr in contact

with the side of the tank, and 300 roentgens per hr in contact with the bottom tube sheet.

In order to appreciate the magnitude of this radiation measured in terms of roentgens per hour, if one hundred people were to receive a total body irradiation of 400 roentgens, at least fifty of these people would definitely have received a lethal dose. For this reason the normal health tolerance has been limited to 300 milliroentgens per week which is applied as a very rigid control on all employees working with radioactivity. However, had we attempted to apply this rigid tolerance when working with the activities involved due to this accident, we would have very quickly run out of manpower to handle the job.

Reconstructing the Reactor. On reconstructing the reactor all of the equipment removed was decontaminated and used over again, such as shields, water headers, pipes, valves, instruments, and so on, with the exception of the aluminum tank and one steel shield immediately above the tank which were purposely damaged beyond repair in order to simplify the removal of the ruptured rods. These two pieces of equipment were replaced by new equipment.

Additional Safety Measures

From investigating the causes leading to the power surge in the NRX Reactor on December 12, 1952, and taking advantage of our experience in dismantling and reconstructing the reactor, a number of alterations were made in our operating procedures and in the design of the reactor to improve the safety and simplify the problems of decontamination in the future. Some of these improvements are as follows:

1 Keeping in mind that the NRX Reactor is essentially a research unit and not a production unit as would be the case for a power reactor, we have formed in our operating organization a small group which we call "Reactor Safeguard." The head of this group was chosen from a high level in the organization, in terms of years of experience and knowledge of operating a nuclear reactor, and this head reports directly to top management. His responsibility is to keep management fully informed in advance of any research or experimental program or any alteration in the routine operation that might affect the safety which was originally designed into the control of the reactor.

2 Previously the shutoff rods in the reactor were removed in groups when starting up the unit. At present a mechanical valve, in addition to electrical controls, has been installed, thereby providing two independent means for controlling the sequence of removal of shutoff rods from the reactor. Of course it must be kept in mind that the NRX Reactor is heavy-water moderated and the critical size is dependent on both the load in the reactor at any particular time and the heavy-water level in the aluminum tank.

3 Rate-of-rise amplifiers have been installed which automatically trip the shutoff rods into the reactor should the power increase exceed a preset rate.

4 Additional signals have been installed to indicate when the shutoff rod is neither in the up nor the down position.

5 Routine checks are made on dropping the shutoff rods; when a rod fails to drop to the down position it is removed promptly from the reactor and replaced immediately.

6 In building any nuclear reactor the ease of dismantling the unit must always be incorporated in the original design.

7 When building a reactor which requires heavy water or light water as a coolant, all surfaces below the reactor should be of a smooth finish and nonabsorbent.

Bare concrete is a very poor material when exposed to radioactivity accompanied by a liquid. The activity enters the concrete to the distance where the liquid or moisture is absorbed and the only method for removing this activity is by chipping and grinding away the concrete to the distance that this absorption has taken place. For this reason the concrete surface should be sealed as tightly as possible.

8 All panel boards for instruments and equipment that, of necessity, must be located below the reactor should be suspended from the ceiling above rather than attached to the floor. If equipment must rest on the floor it is essential that the point of contact between the equipment base and the floor should be completely cocooned in order to prevent active liquid from running in beneath the base of the equipment and down through boltholes or cinch anchors buried in the concrete.

9 An ideal design directly under a reactor that contains liquid is that in which a large funnel is installed to collect all the active solution that leaks away from the unit above and the material caught in the funnel should be piped to one controlled central point.

10 Whenever lead is used for shielding or protection on floors and walls under or adjacent to a reactor, design should be such that the lead is easily removed for decontamination purposes. Our experience has been that the simplest method of decontaminating lead is to melt it; by skimming the slag off the surface the major portion of the activity is removed. The decontaminated lead is then remolded for further use.

11 All horizontal surfaces in the main reactor building, including overhead girders, cranes, etc., should be sealed with a material of a smooth finish thereby easing the problem of decontamination.

12 The vertical surfaces, such as the walls of the building, should also be of as smooth a surface as possible in order to ease the problem of decontamination.

13 The ventilating system in a reactor building should be designed with enough extra inlets to provide a quick means for attaching portable connections in special locations when emergencies arise. The problem of controlling the ingested activity by workmen carrying out repairs in or around the reactor is of as great importance as the control of total body irradiation. In our case, all workmen were forced to wear respirators or fresh-air masks for a period of 10 months when carrying out the renovation of the reactor.

14 Permanent facilities in a heavy-water reactor or a light-water enriched reactor always should be available for pumping large volumes of water containing activity into a sand and clay disposal area. Pumping through ion-exchange resins also could be used for this purpose with the plan of burying these resins after they have been used. However, this procedure is far more costly.

The Present Status of Steam Properties[1]

The need for data at higher temperatures and pressures to perfect the knowledge of water substance calls for international co-operative action

By Frederick G. Keyes[2] and Joseph H. Keenan[3]

Massachusetts Institute of Technology, Cambridge, Mass.

THE Third International Steam Tables Conference held in the United States in 1934 reviewed the reports of investigations of steam properties submitted by the investigators from the United States, England, Germany, and Czechoslovakia. The reports considered were based upon some ten years of measurement effort begun under the auspices of the ASME, following a meeting of scientists, engineers, and turbine designers in Cambridge, Mass., at Harvard University, in June, 1921.

Results of Conference

The result achieved by the third conference of 1934 was the definitive International Skeleton Steam Tables,[4] accompanied by estimates of accuracy, or "tolerances," and included the designation of fundamental units, definitions, and conversion relationships.

The primary purpose to be served in devising the skeleton tables was to designate at comparatively large temperature and pressure intervals values pertaining to the saturation state of water substance and the superheat region over the entire ranges of these variables which had become accessible to the scientific investigators. The data following from three independent investigations of vapor pressures from 0 to the critical temperature (374.15), the phase-boundary volumes of the liquid, the heat capacities of the saturated liquid, and the heats of evaporation were available. In the superheat the enthalpies were available from independently conducted measurements to 550 C (600 C was reached by our British colleagues) and to pressures of 300 atm. The heat capacities of the superheat region were also available from direct measurement to 450 C and to pressures of 200 atm. Joule-Thomson measurements were available over the range 125 to 347 C and to 40 atm. Measurements of the volumes of the compressed-liquid phase had been made to nearly 350 atm and to the critical temperature. The data on volumes of the superheat extended from 2 cc per g to 150 cc per g, and to temperatures of 460 C. This extensive ensemble of painstaking experimental investigations comprised the basis of the skeleton tables. The published tables became available to anyone, anywhere, for the preparation of detailed steam tables which would be considered "International Tables," provided the values contained therein were within the tolerances set by the Third International Conference group.

It was the cherished hope of the conferees in 1934 that the limits of temperature range, 550 C (1032 F) and of pressure, 350 atm (5000 psia) attained in the investigation of water substance would serve all requirements in the science and art of power production for the lifetime of the youngest conference participants. The hope has not been realized for now we envisage the need for accurate data at even higher temperatures and greater pressures.

Nor is this all, for we require far more exact and verified data for the viscosity and thermal conductivity of water substance than exist at present. Finally, it is now highly desirable that a comprehensive investigation be pursued on the relation of the international scale of temperature to the thermodynamic scale. In the scientific sense it is only the latter scale which finds full logical justification when employing the laws of thermodynamics. Indeed we now know, thanks to James A. Beattie's gas thermometric investigations, that the available steam data are consistent in the thermodynamic sense, although there are deficiencies in our knowledge of the scale relationship above the range 0 to 444.6 C.

The satisfying success of the earlier international co-operative effort to perfect our knowledge of water substance, culminating twenty years ago, suggests that the present need for data at higher temperatures and pressures may find fulfillment under a similar organization. It is with this hope that the present statement has been drawn up. In what follows a brief presentation is made of the extent, in terms of the variables pressure and temperature, of our existing knowledge. The extension to larger values of these variables through a form of international organization adapted to present circumstances is urgent.

Since the 1934 international conference, considerable new data and important correlations of experimental findings have been reported. Thus may be cited the following: (1) Very accurate measurements of essentially the heat of evaporation[5] between 0 and 100 C. (2) The development of the means for measuring the change of enthalpy with pressure at constant temperature with data in the range 40 to 125 C, leading to exact values of volume in a region inaccessible to accurate measurement by direct means.[6] (3) The

[1] Prepared for the ASME Research Committee on Properties of Steam.

[2] Professor Emeritus and Lecturer, Department of Chemistry, Massachusetts Institute of Technology. Mem. ASME.

[3] Professor, Department of Mechanical Engineering, Massachusetts Institute of Technology. Fellow ASME.

[4] MECHANICAL ENGINEERING, 1935, p. 710.

Contributed by the Research Planning Committee and presented at the Annual Meeting, New York, N. Y., November 28–December 3, 1954, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[5] N. S. Osborne, H. F. Stimson, and D. C. Ginnings, *Journal of Research*, U. S. National Bureau of Standards, 1939, p. 197.

[6] S. C. Collins and F. G. Keyes, Proceedings of the American Academy of Arts and Sciences, 1938, p. 283.

accumulation of data relating to the infrared spectrum of water vapor from which definitive values of the specific heat of water vapor in the ideal-gas state have been computed.[7] (4) G. C. Kennedy's p-v-T relationships in water to high temperatures and pressures.[8] (5) The direct measurement of p-v-T properties of steam between 531 and 600 C, and to pressures of 500 atm.[9] Also, (6) data for C_p in the superheat.[10] These valuable contributions to our knowledge of equilibrium states have been supplemented by (7) much work on the transport properties, viscosity, and thermal conductivity so vitally important in the applications of heat-transfer theory. The results now available, however, appear to require verification.

Proposal to Extend Temperature Range. The proposal is advanced as a point of departure for discussion that additional measurements be obtained to extend the temperature range of verified data to 800 C (1500 F) and 1000 atm (15,000 psia). (1) The following quantities are proposed for measurement: The enthalpy for steam from 500 C. (2) The p-v-T properties from 500 C, not alone by direct measurement but from measurement of (3) the enthalpy change with pressure at constant temperature. This differential quantity is a direct measure of the departure of a fluid from the ideal-gas state and leads to a valuable confirmation of the accuracy of the directly measured p-v-T properties. The apparatus for measuring the enthalpy change with pressure can be designed to permit (4) the measurement of specific heats, and (5) Joule-Thomson coefficients.

Viscosity of Steam Measurements. In addition to the foregoing equilibrium quantities, it is proposed that the viscosity of steam be measured to at least 800 C and to pressures of 1000 atm. Similar ranges are proposed for the thermal conductivity.

The relation between the International Scale of temperature and the thermodynamic scale has been determined recently to the sulphur boiling point. The results of the foregoing scale investigation should, however, be confirmed and extended to the silver calibration temperature, 960.8 C.

Fig. 1 shows in pressure-temperature co-ordinates the areas covered by the investigations of the first international effort, and also includes later investigations to date. G. C. Kennedy's work, which extends to 1000 C (1832 F) and to nearly 2500 atm (37,000 psia) is not represented in Fig. 1. Professor Kennedy is verifying his measurements on steam, particularly in the region of immediate interest for steam tables. In consequence of this circumstance, these extensive measurements will be reviewed at a later date. The reported results of investigations undertaken to test the thermodynamic consistency of the existing body of experimental

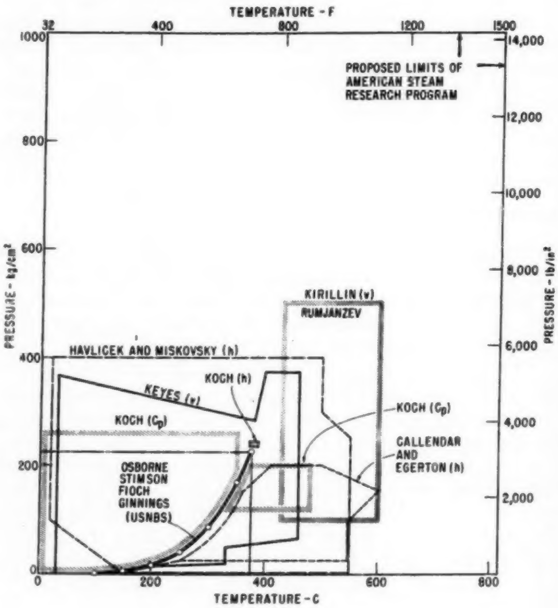

Fig. 1

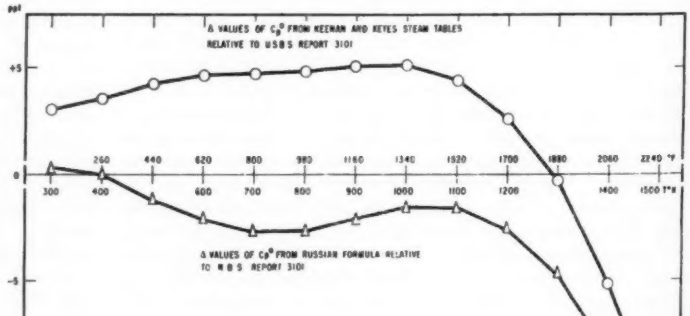

Fig. 2

[7] National Bureau of Standards Report No. 3103.

[8] G. C. Kennedy, *American Journal of Science*, 1950, p. 540.

[9] *Elektritschcskije Sstanzii*, vol. 21, no. 12, 1950, pp. 8–14.

[10] D. L. Timroth and N. B. Vargaftik, USSR *Journal of Physics*, 1940, p. 101.

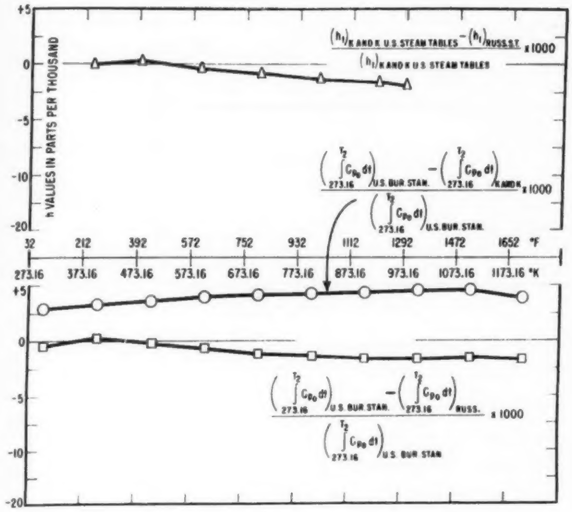

Fig. 3

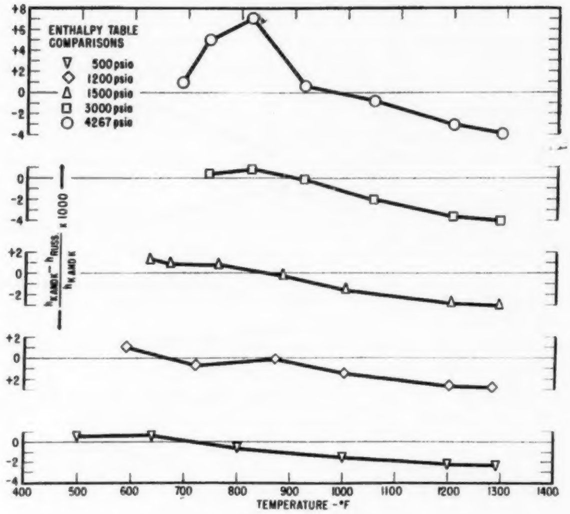

Fig. 4

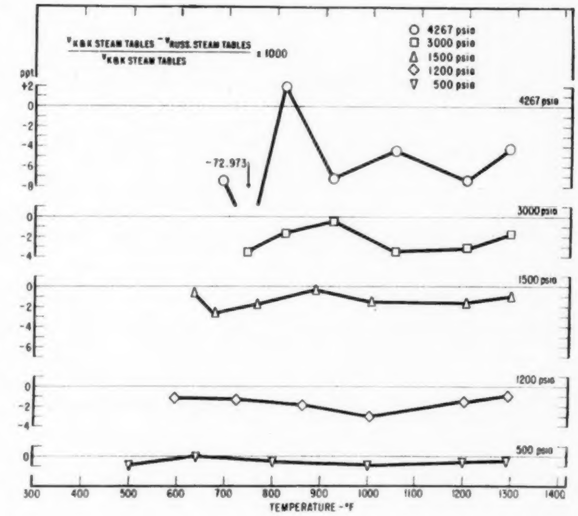

Fig. 5

results, and making use of the temperature-scale comparisons to the sulphur point (444.6 C) are satisfying. It follows, therefore, that new investigations extending the old limits of pressure and temperature may start out with a tested array of experimental findings to 550 C and about 350 atm. In addition to this encouraging background the correlating equations evolved in dealing with the existing data will serve to provide reasonable "expectations" of magnitudes in the extended region. Thus the details of the design of measuring equipment can be determined with the advantage of knowing the order of magnitude of values sought.

The U. S. Steam Tables[11] were compiled with the knowledge that definitive values for C_p^0 could not be had until further data were available relative to the infrared spectrum of water vapor. This definitive information is now available.[7] Fig. 2 will convey an impression of the differences in C_p^0 used in two steam tables relative to National Bureau of Standards values, while Fig. 3 represents differences in the enthalpy quantity $\int_{T_0}^{T} C_p^0\, dT$ based on the definitive C_p^0 values and the same integral derived from the values of C_p^0 employed in the U. S. Tables and the recent (1951) Russian Tables. At the top of the figure the differences of the 1 kg/cm² enthalpies as tabulated in the two foregoing tables are exhibited. The Russian Tables make full use of the International Skeleton Tables of 1934, using C_p^0 values resulting from a Russian treatment of the spectral data. The Russian Tables tabulate values to 700 C (1292 F) and 300 kg/cm² (4270 psia). The latter tables also contain detailed tables for viscosity and thermal conduction based exclusively on Russian investigations of these transport properties.

The tabulated enthalpies for several constant pressures from the U. S. and Russian Tables have been compared and the differences appear in Fig. 4. A similar chart of the volume difference is represented in Fig. 5.

In 1950 a paper by W. A. Kirillin and L. L. Rumjanzev[9] appeared giving values of pressure and volume at six temperatures, 431.34 C (808 F) to 600 C (1100 F), and to pressures of 500 atm (7100 psia). These data provide an extension in temperature of 140 C and in pressures of some 150 atm over the limits of the directly measured values of volume available to the 1934 conference. Fig. 6 gives an impression of the relation of these new measurements to similar values computed from the Russian Tables equation of state. Definite knowledge is lacking regarding the use of the new Russian volume data in the preparation of the 1951 tables.

Fig. 7[12] gives a survey of comparisons representing differences between the reported pressures of the recent Russian p-v-T measurements and pressures computed from an equation of state based on the Skeleton Tables

[11] "Thermodynamic Properties of Steam," by J. H. Keenan and F. G. Keyes, John Wiley and Sons, Inc., New York, N. Y., 1936.

[12] Fig. 7 has been reproduced by permission from National Bureau of Standards Report No. 2535, fig. 2 of that report; also figs. 9, 10, and 11 are figs. 4, 5, and 6 of the same report.

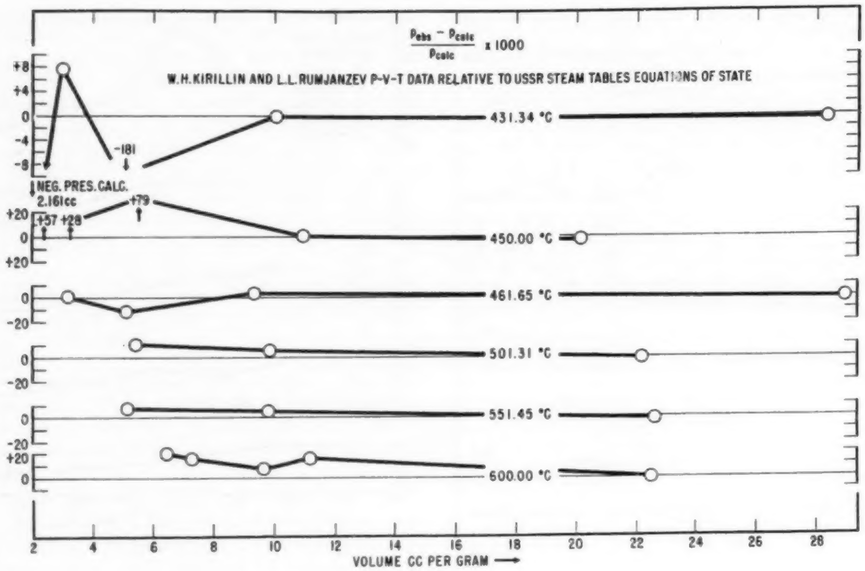

Fig. 6

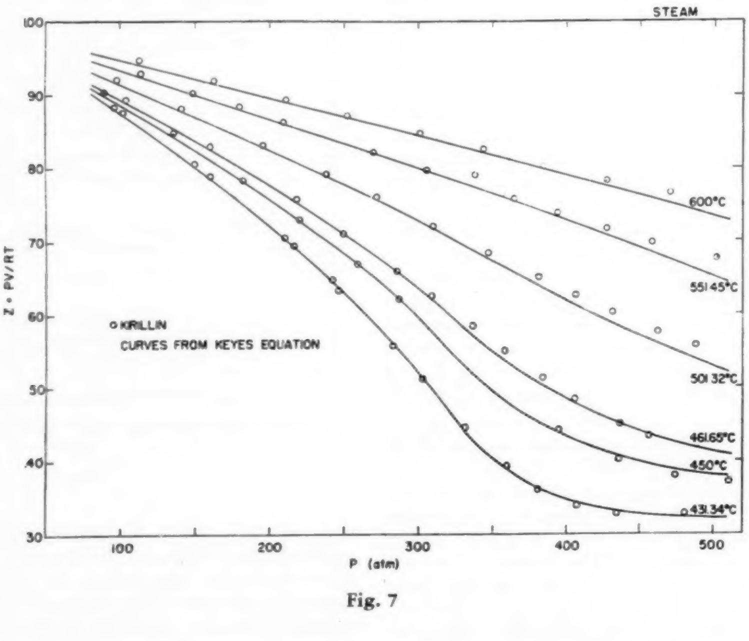

Fig. 7

p-v-T data. Fig. 8 is a graph comprising pressure differences between the Russian data and pressures computed from the equation of state.

Viscosity and Thermal Conductivity

It is widely known that reported measurements of the viscosity of steam are highly discordant. The viscosity of a gas or vapor is very small, and the control of the conditions necessary for realizing accurate values difficult.

The methods employed for the measurement of viscosity comprise the use of a capillary where the volume of gas issuing from the capillary is observed under a constant difference of pressure. The flow regime in the capillary must of course be strictly "streamline" which implies clearly that the rate of flow must be small; strictly speaking, infinitely small. The capillary method has furnished most of the data for all substances in both the liquid and vapor or gas phases. The existing data for steam have for the most part been obtained by the capillary-tube method and the results, while not in

satisfactory accord, do indicate that the quantity is a diminishing function of pressure with rising temperature.

A classical method for measuring gaseous viscosity was employed by Maxwell, that of the oscillating disk. The method has been developed to a state of considerable perfection by Prof. J. Kestin of Brown University, and it may provide an important independent verification of steam viscosities obtained by the capillary method which Prof. W. L. Sibbitt at Purdue University is employing.

A survey of the relation of reported viscosity values by different observers is provided through the reproduction of three figures from a National Bureau of Standards Report (No. 2535, 1953). Fig. 9 indicates the differences of the reported lower-pressure values from a selected formulation, and similarly for later higher-pressure values in Figs. 10 and 11. These figures are useful mainly to convey an impression of the very unsatisfactory state of accord of the reported values.

Fig. 12 represents the results of an attempt to deduce the values of viscosity for pressures approaching zero in the case of three of the investigators who have reported results over a wide temperature range. Except above about 400 C, the results are in fair agreement. However, above this temperature the trends differ markedly.

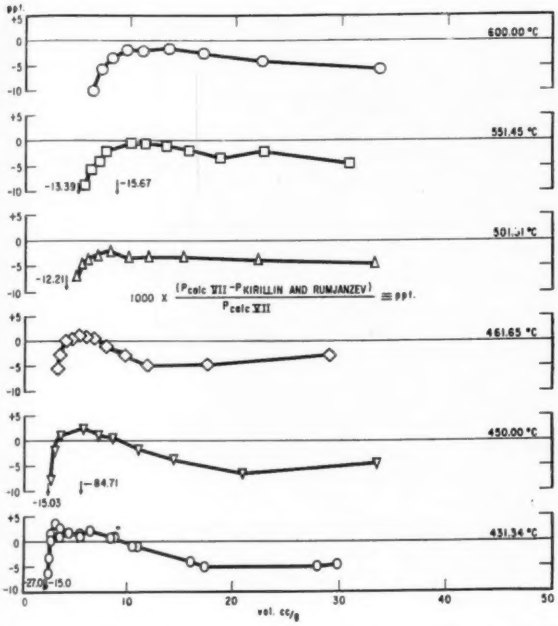

Fig. 8

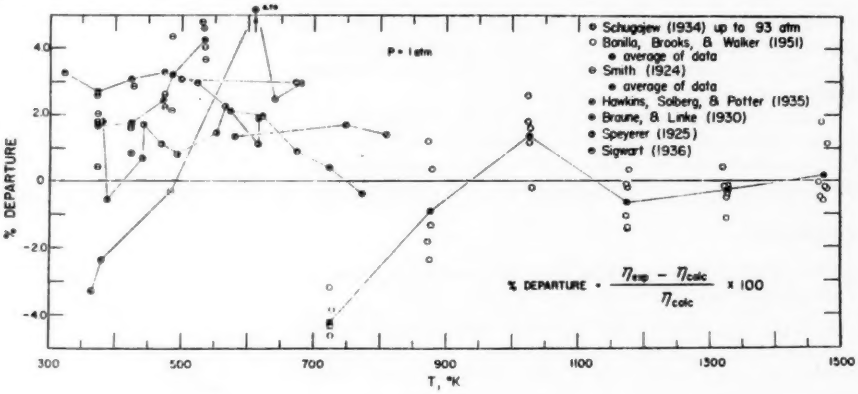

Fig. 9

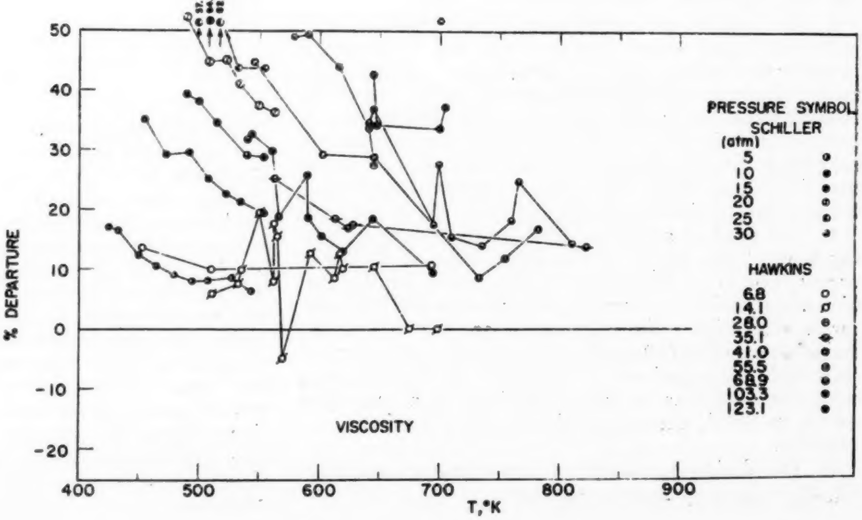

Fig. 10

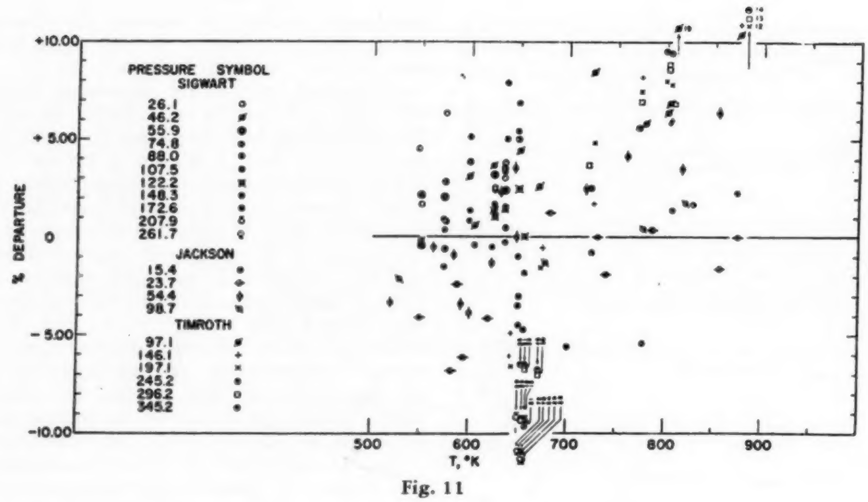

Fig. 11

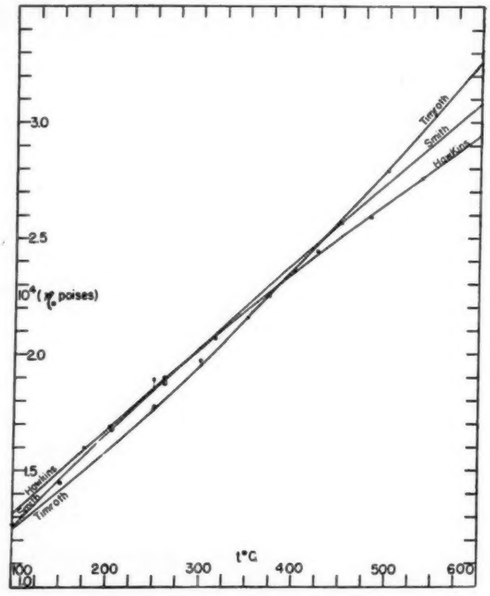

Fig. 12

The thermal-conductivity values reported for steam are even more discordant than the viscosity values. The conductivity depends upon pressure to as important a degree as for viscosity.

The most comprehensive investigation of thermal conductivity was carried out in Russia and reported in 1940, over a range of pressure (250 atm) and temperature (550 C). Recently[13] values smaller than the Russian were reported to 150 atm and 350 C.

In addition, work is in progress (at M.I.T) seeking to extend measurements at low pressures to 750 C. The heat conductivity of steam is in a most unsatisfactory state on the basis of reported results.

Conclusions

The present status of the 1934 International Skeleton Tables data may be summarized as follows:

1 The accuracy of the data is established by the test of thermodynamic consistency when the test is carried out employing the results of the recent experimental comparison of the international-scale temperature with the thermodynamic scale.

2 The additional experimental data reported for water substance since 1934 indicate no trend which in any way reflects against the accuracy of the 1934 table. There is an exception, however, in the case of the 1950 Russian data which extend beyond the 1934 superheat volumes in temperature and in pressure. Pressures computed using the equation of state based on the Skeleton Tables superheat data fail of agreement with new Russian data, being smaller by the order of one per cent.

3 The need of additional experimental data extending beyond the range of the 1934 Skeleton Tables is urgent, not alone for present design needs, but for turbine design suited to even higher pressures and temperatures. The higher limits proposed are 800 C (1500 F) and 1000 atm (15,000 psia). With contemporary materials and the experience accumulated earlier, together with the 1934 data of proved accuracy as a base upon which to build, these very high limits are believed attainable.

4 The design treatment of heat-transfer equipment depends upon reasonably accurate data for viscosity and thermal conductivity. It is imperative that the present discordant array of transport quantities be disposed of through new research. The viscosity and thermal conductivity should be known at low pressures with an accuracy of at least 1 per cent to 800 C and to pressures of 200 atm to temperatures of 400 C. The pressure effect falls so rapidly with temperature increase that it need not be measured to 800 C.

There is scarcely need to remark upon the desirability of devising an international organization to carry out the suggested program. The happy outcome of the earlier venture in international co-operation is persuasive evidence that the next great advance in our knowledge of water-substance properties may be even more significant than that which terminated with the 1934 conference.

[13] Trans. ASME, vol. 72, 1950, p. 72.

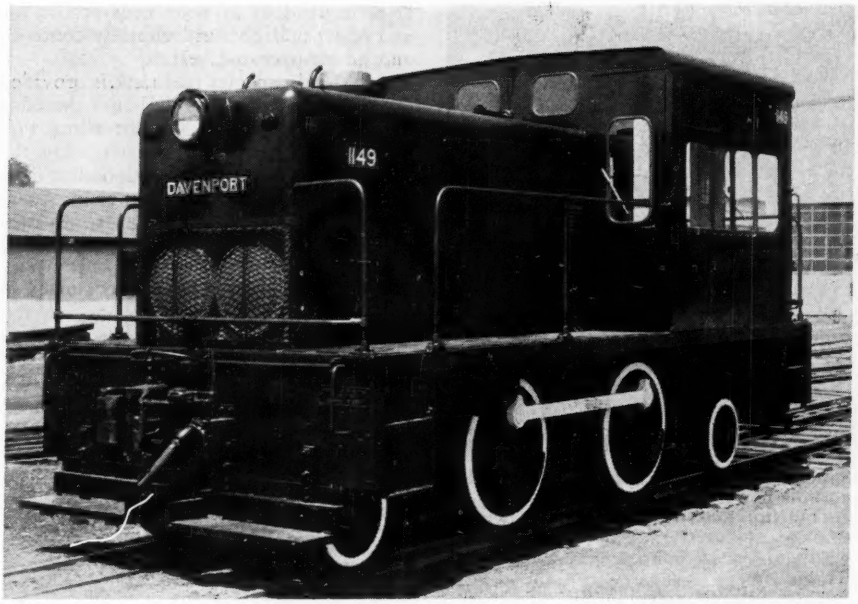

Fig. 1 View of gas-turbine locomotive of a new type developed under the direction of the Transportation Research and Development Command, U. S. Army

Development of the First Gas-Turbine Mechanical-Drive Locomotive

A 30-ton, 300-hp locomotive design for military use in switching and light road service

By Edson L. Barlow, Jr.

Project Engineer, Transportation Research and Development Command, U. S. Army, Fort Eustis, Va.

Realizing the tactical advantages of simplicity and good cold-weather operation, the Transportation Corps of the U. S. Army initiated a study in 1950, of the application of gas turbines to railway motive power. This preliminary study resulted in the following conclusions:

1 There existed the need for an extensive and practical study of this type of power which promised to supersede conventional forms of engines in many applications.

2 Further, there existed the need for a study of mechanical-drive applications to gas-turbine locomotives since the gas turbine has inherent torque characteristics which are ideally suited to a mechanical transmission.

3 These needs could be satisfied and invaluable experience could be gained economically by building a lightweight experimental locomotive which would be suitable for both switching and light road service and which would be comprised of as many standard components as possible.

4 The study of this small locomotive would be a direct approach to larger applications.

This paper is a summary report of the progress thus far attained in the execution of this project.

Mechanical Construction

In the interests of roadability in spite of the lightweight, it was decided to use a standard 30-ton switching locomotive with a 2–4–2 wheel arrangement. This then indicated a power plant with a horsepower rating of from 180 to 360 hp, on the basis of 6 to 12 hp per ton. Design details based on these specifications resulted in the construction of the locomotive shown in Fig. 1.

The chassis was built by the Davenport Besler Cor-

Contributed by the Gas Turbine Power Division and presented at the Annual Meeting, New York, N. Y., November 28–December 3, 1954, of The American Society of Mechanical Engineers. (Condensed slightly from ASME paper 54—A-183.)

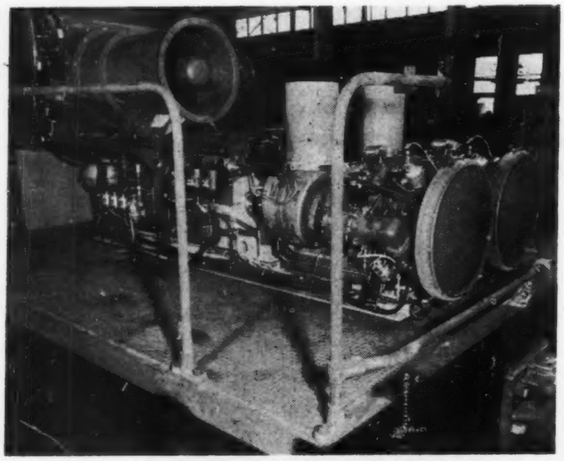

Fig. 2 Right-front-corner view of locomotive with hood removed showing turbine power package. Note especially the circular oil-cooling radiators and attached air ducting in upper-left-hand corner.

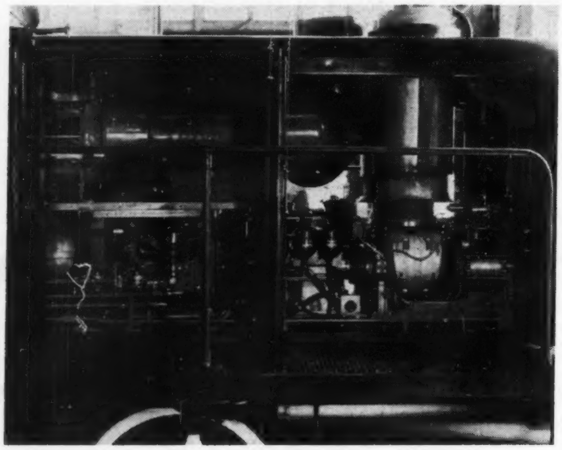

Fig. 3 Right side of locomotive with panels open, showing complete installation of Boeing model 502-2E twin gas turbines and transmission and auxiliary equipment

poration, Davenport, Iowa. It is a 30-ton, standard-gage, 2–4–2 locomotive with the cab mounted on one end and a hood which encloses the power plant mounted on the other end, Fig. 1. The main frames and bumpers are rolled-steel slabs and the frame assembly is welded to insure maximum rigidity and strength. The spring rigging consists of semielliptic and equalized springs supporting each journal box on the drivers and coil springs on the trucks.

Side-rod coupling is provided between drivers as only one axle is driven by the transmission. The journal boxes are of the Timken taper-roller-bearing type, designed to take all thrust and radial loads.

The locomotive is supplied with Westinghouse schedule 6SL straight and automatic air brakes, a hand brake for holding the locomotive when not in use, air sanders designed to sand the rails ahead of the locomotive for either direction of travel, AAR type E couplers with release rigging operable from either side of the locomotive, footboards at both ends of the locomotive, front and rear headlights individually controlled, an air horn, and an air-operated bell.

A 200-gal-capacity fuel tank is provided. While this is considered extremely small in view of the high rate of fuel consumption of a gas turbine (approximately 50 gph under full-load conditions for this application), it was found that it was impossible to provide a larger capacity without a major revision to the frame of the locomotive. Such a revision to an otherwise standard item would impose a high cost which did not seem justifiable in an experimental locomotive.

Table 1 General Specifications of 30-Ton Gas-Turbine Locomotive

Wheel arrangement	2–4–2
Nominal weight, tons (U. S.)	30
Weight on drivers, lb	50000
Weight on each truck, lb	5000
Over-all wheel base, ft-in	16–8
Wheel base of drivers, ft-in	6–0
Length over couplers, ft-in	24–6
Height above rail (top of cab), ft-in	11–2
Width over-all, ft-in	9–8
Radius of sharpest curve, ft	100
Maximum speed, mph	35
Fuel capacity, gal	200
Power plant—rating of each turbine at standard conditions (60 F, 29.92 in. Hg)	
Brake horsepower (continuous)	150
Gas-producer speed (maximum), rpm	35000
Output-shaft speed (maximum), rpm	2750
Output-turbine speed (maximum), rpm	23700
Exhaust-gas temperature (maximum), deg F	1125
Specific fuel consumption (at rated hp), lb per hphr	1.40

Table 1 is a résumé of the general specifications of the 30-ton gas-turbine locomotive.

Power Plant

The power plant was built by Boeing Airplane Company, Seattle, Wash., and consists of two Boeing Model 502-2E gas turbines which operate in parallel through a combining gear. The complete power plant including accessories is mounted on a base which can be removed from the locomotive frame as a unit to facilitate maintenance and overhaul, Fig. 2. The complete installation is shown in Fig. 3. The Boeing Model 502-2E gas turbine consists of two major sections, namely, a gas producer and a power-output section. The gas producer contains a centrifugal compressor coupled to a single-stage axial-flow turbine, two combustion chambers, and an accessory-drive section. The power-output section incorporates a second axial-flow turbine, reduction gears, and an output shaft, and is joined to the gas producer by a duct.

Mounted on the gas-producer section of each turbine is a 24-volt combination generator starter which serves the dual purpose of starting the turbine and charging the battery once the turbine is running.

Control of the turbine is accomplished by means of a governor which controls the speed of the gas-producer section. The governor setting is pneumatically actuated by the operator's throttle lever.

The fuel supply for each turbine is turned on or off by an electric solenoid valve controlled by a switch located

at the operator's position. Provision is incorporated into this circuit for automatic turbine shutdown in case of low lubricating-oil pressure or output-turbine overspeed.

The turbine as installed is designed to operate on diesel fuel. However, it is possible to run the turbine on other fuels such as jet-engine fuel, kerosene, gasoline, or light fuel oils, with minor adjustments to the turbine.

Power from the two turbines is combined to drive the transmission at reduced speed through a combining reduction gear. The output of each turbine is coupled to the combining gear through an overrunning clutch which allows single-engine operation of the power package.

An air compressor for the brakes and control air is driven off the output of the combining gear. This compressor is an air-cooled, two-cylinder, two-stage type with approximately 40 cfm displacement.

Mounted behind the engines and above the transmission is the lubricating-oil-cooling assembly, which consists of four separate cylindrical radiators, one for the oil from each turbine, one for the combining gear lubricating oil, and one for the transmission lubricating oil.

Twin-Turbine Concept

The decision to use two turbines instead of one was based upon indications that such a setup would result in the following advantages:

1 Better fuel economy at partial load. One characteristic of the gas turbine which is a disadvantage for vehicle application is that the fuel consumption at partial load is extremely high; e.g., at one-quarter load the fuel-consumption rate is about 60 per cent of the full-load rate in quantity of fuel per period of time. The use of two turbines partially obviates this disadvantage since at half load one engine can be shut down, thus using the running engine at its peak efficiency.

2 Either turbine can be used to carry the base load. Thus, if one turbine should break down, it would be possible not only to get the locomotive back to the shop but also to do a limited amount of work using the remaining turbine.

3 Permits derating the turbine to increase life. The Boeing Model 502-2E is normally rated at 175 hp at standard conditions. However, in this particular application each turbine has been derated to 150 hp by limiting the maximum speed of the gas-producer section. Further, the time required to accelerate the gas-producer section from idle to full speed has been increased from 4 to 6 sec by adjusting the acceleration limiter in the fuel control. It is anticipated that the life of the turbine will be increased appreciably by these adjustments since the speed of the gas producer and the temperatures encountered during acceleration have a marked effect on turbine life.

4 The increase in weight and space is negligible because of the low-weight and compactness characteristics of the gas turbine.

Mechanical Drive

The output of the combining gear is coupled to the input of a Model TG-602 "Torqmatic" transmission which is manufactured by the Allison Division of General Motors Corporation. This transmission consists primarily of a compound planetary-gear train, which is in constant mesh, and provides, through the action of hydraulically actuated clutches, gear ratios of 4.4:1, 2.33:1, and 1:1. Positioning of the ratio selector which controls the hydraulic actuation is done by a four-position pneumatic cylinder with manual selection by the operator.

The Torqmatic transmission is capable of making quick shifts under full loads at wide-open throttle without interrupting the power flow from the turbines to the drivers. As will be pointed out later, this characteristic proved to be a disadvantage for this application.

The driving wheels are powered by the Torqmatic transmission through an axle-hung transmission which not only provides right-angle drive to the drivers but also serves as a reversing transmission thus providing, in conjunction with the Torqmatic transmission, three speed ranges in either the forward or reverse direction. Shifting of this transmission is done by a two-position pneumatic cylinder with manual selection by the operator.

Preliminary-Performance Analysis

An analytical study of the performance and operating characteristics of the twin-turbine power plant installed in the locomotive promised several desirable characteristics. Among these are a top speed of 35.5 mph, a maximum tractive effort of approximately 15,000 lb, and the ability to haul 18 loaded freight cars at 18 mph, or 5 loaded cars at 34 mph.

For the purposes of the analysis it was assumed that the two turbines would drive through the combining gear (gear ratio–1.375:1), the Allison Model TG-602 Torqmatic transmission (gear ratios of 4.4:1, 2.33:1, and 1:1), and a driving axle having a gear ratio of 6.7:1. In the calculations allowance was made for a 20-hp auxiliary load (air compressor, etc.) and a transmission efficiency loss of 10 per cent.

Fig. 4 is a plot of gross tractive effort produced at various speeds under standard atmospheric conditions for single and two-engine operation. A slip point of 15,000 lb tractive effort was determined by using a coefficient of adhesion between the track and the driving wheels of 0.30, since the turning moment produced by the turbines is uniform. Use of this value assumes reasonably clean drivers and rails.

Fig. 5 contains curves showing the number of empty (25 tons) and loaded (70 tons) 4-axle freight cars which can be handled on a straight level track under standard atmospheric conditions. Note that the number of cars handled at low speeds is limited by the number which can be started from rest.

Owing to the experimental nature of this locomotive, the operator is confronted with an array of meters, levers, and switches. The proper manipulation of these controls is rather complicated as little attempt has been made to provide automatic controls.

Shakedown Testing

On May 7, 1954, the locomotive was towed out of the shop and into the yards of the Davenport Besler Corporation for its initial running and shakedown testing prior to delivery. First one and then the other turbine was fired and after the necessary last-minute checks were

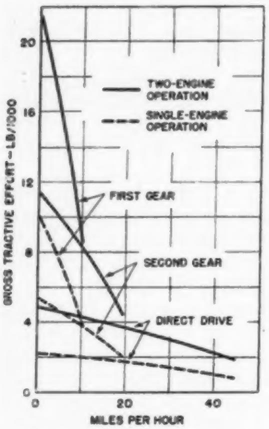

Fig. 4

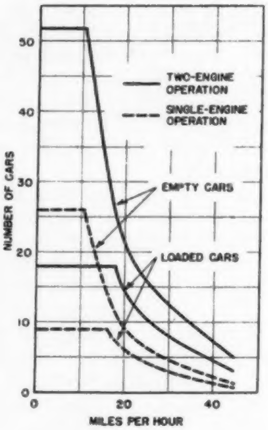

Fig. 5

Fig. 4 Plot of gross tractive effort produced at various speeds under standard atmospheric conditions (60 F, 29.92 in. Hg). Gas-producer speed is 34,650 rpm and exhaust temperature is 1110 F.

Fig. 5 Curves showing number of cars which can be handled on straight level track under standard atmospheric conditions (60 F, 29.92 in. Hg). Gas-producer speed is 34,650 rpm and exhaust temperature is 1110 F. The weight is assumed to be 25 tons for empty cars and 70 tons for loaded cars.

completed, the locomotive was put in gear and moved for the first time under its own power.

In the two weeks that followed, the locomotive was run almost every day and accumulated approximately 5 hours of operating time on each turbine. As can be expected in an experimental item, innumerable "bugs" developed and had to be corrected. The locomotive ran smoothly and its tracking ability was excellent even on the very rough track encountered in the yard. The acceleration, even under load, is not only smooth but remarkably fast for a locomotive of this size.

Shifting Shock

During the course of the shakedown testing it became apparent that one "bug" was going to give trouble. When the Torqmatic transmission was shifted into gear from neutral the locomotive drive train was subjected to a severe shock. This shock was caused by the combination of two factors, namely, (1) the quick engagement of the Torqmatic transmission, and (2) the kinetic energy of the revolving parts ahead of the transmission which include the combining gear, the air compressor, the output-turbine wheel, and related shafting. The shock was so severe that, with the brakes released, a transmission engagement would produce a wheel slippage of approximately 10 deg.

A reinvestigation of the problem showed that the end rate of transmission engagement was far too fast for this application.

It was obvious that some solution to the problem must be devised before the locomotive could run any further—otherwise extensive damage might result. A pneumatically actuated hand brake on the transmission input shaft was added as a temporary expedient. This slowed the shaft to a point where a smooth engagement could be made but it also required one more control the operator must remember to use. Studies are being conducted to determine if there is a way in which the transmission can be modified effectively to slow down the engagement, thus eliminating the need for this transmission-shaft brake.

Combining-Gear Failure

Fifteen days after the locomotive was first started, the effects of the shifting shocks proved to be too much for the combining gear. The locomotive had just finished a series of simulated switching tests when it was decided to make an acceleration run of the locomotive alone, using both engines. This run was normal up to the point of the second-to-third gear upshift, at which time there was a loud breaking noise and both engines shut down due to overspeed. An on-the-spot investigation showed a jagged hole in the combining-gear housing.

Subsequent teardown of the combining gear revealed serious failure of all its components. The final drive-gear hub and spider were shattered and all gears showed considerable tooth damage. The bearings and the housing, except for the hole, were undamaged.

Analysis of the failure has shown that the loads imposed by the shifting shocks were greater than anticipated in the design and that the repeated shocks caused the failure.

To prevent the recurrence of the combining-gear failure the combining gear was redesigned to provide greater strength, and the Torqmatic transmission was modified to slow the clutch-engagement time.

These changes were to be followed by delivery of the locomotive to the Rock Island Arsenal, Rock Island, Ill., for a 3-month operating test.

Adaptability to Military Use

The development of the 30-ton gas-turbine locomotive has led the author to the following conclusions concerning the design of gas-turbine locomotives for military use:

1 The gas turbine offers distinct advantages over the diesel engine for military use, viz., reduction of field maintenance, simplicity, unit-replacement practicability, and good cold-weather operating characteristics.

2 The gas turbine lends itself readily to mechanical drive even though several outstanding design problems are involved.

3 The gas turbine has several unique characteristics which must be taken into account when a design is formulated, viz., high rate of fuel consumption (larger fuel tank), and simplicity and compactness (more room for other items).

4 The twin-turbine concept with proper control is an important answer to the problem of the relatively high rate of fuel consumption at partial loads.

5 The control system should be designed so that the operation of the locomotive from the operator's viewpoint is similar to a diesel-electric, in order to avoid special training.

6 The gas-turbine mechanical-drive combination will outperform a diesel-electric of the same engine-output rating.

7 The gas turbine as a form of railway motive power is here to stay!

Hydraulic-Turbine Governors Developed to Reduce Outage Time

Modern designs can minimize installation troubles and cut maintenance requirements

By B. R. Nichols

Mechanical Engineer, Hydraulics Section, Power Department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

The design of many hydroelectric units still in operation after 40 years or more of service was based largely on good judgment of the designer and limited field experience.

In contrast, modern hydroelectric generating equipment is based on a wealth of experience gained from field observations on the older units, together with laboratory data obtained on a large selection of materials, and scientific information obtained from experimental work.

Considering the materials and experience available to the designer today, and the vast experience operating departments have gained, it does not seem unreasonable to expect the useful life of modern hydroelectric units to be a hundred years or more.

Today's generating units may operate satisfactorily throughout the useful life of the dam, provided, of course, that factors reducing or eliminating cavitation, erosion, and other causes of destructive action, are considered carefully in the original design of the power plant.

The cost of lost revenue and labor, caused by frequent repair over a period of 100 years or more, could exceed greatly the extra cost of a lower turbine setting, a lower specific speed, or the cost of erosion and corrosion-resistant materials.

The design of auxiliary equipment, in a powerhouse, directly influencing the operation of the generating units, also should be given careful consideration to insure a minimum of maintenance requirements over long periods of operation.

The Governor

The governor is, in a sense, the point of co-ordination between the turbine and external controls; therefore the design of a governor should be given careful consideration if unnecessary outage time of the unit is to be avoided. The principal elements will be discussed.

Speed-Responsive Element

The centrifugal flyball only will be discussed in this paper. To maintain a sensitivity of 0.01 per cent, frequently specified in governor specifications issued during the past 20 years, it is very important to consider the construction of joints between the various structural members of the flyball. The joint friction caused by relative motion of these members should be reduced to a minimum, and also designed so that the degree of friction between the various moving parts will not increase with length of operating time.

Experience has demonstrated that a flyball having the weights attached to flat leaf-type springs, illustrated in Fig. 1, will fulfill these requirements.

It has been common practice for many years to transmit the flyball motion by mechanical means through a system of floating levers to a pilot valve which hydraulically positions the main relay valve in the governor.

A change of flyball speed of 0.01 per cent (0.006 cycle on a 60-cycle system) produces a very small change in flyball energy; therefore the floating levers must be relatively light in weight. Small changes in joint friction will cause inaccurate transmission of flyball signals to the pilot valve. This inaccuracy has been overcome by transmitting the flyball signals hydraulically to the relay-valve actuator piston.

The relay-valve piston may be designed to produce considerable thrust and therefore is capable of positioning relatively large rigid levers, through which the relay-valve motion is transmitted back to the flyball.

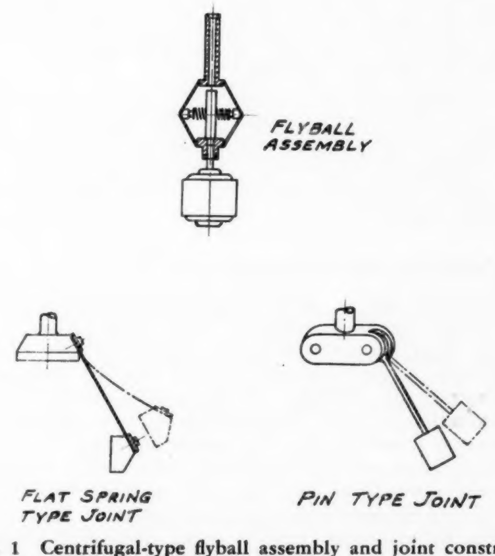

Fig. 1 Centrifugal-type flyball assembly and joint construction between structural members

Contributed by the Hydraulic Division and presented at the Fall Meeting, Milwaukee, Wis., September 8–10, 1954, of The American Society of Mechanical Engineers. (Condensed from ASME Paper No. 54—F-17.)

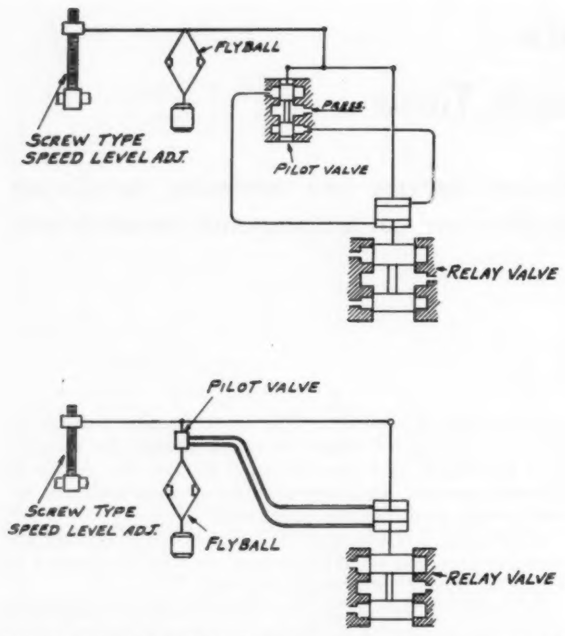

Fig. 2 Conventional floating-lever system, *top*, as compared with improved design

Normal pin-joint friction in this type of floating-lever mechanism then becomes a small percentage of the available thrust, as contrasted with the joint friction becoming a large percentage of available thrust in the more common type of floating-lever system.

The two types of floating levers are illustrated schematically in Fig. 2.

The Flyball Drive

The most common method of driving the flyball in synchronism with the generating unit is by connecting the flyball directly to a synchronous-motor shaft, the motor receiving its energy from a permanent-magnet generator (PMG) coupled to the generator shaft, by means of a flexible coupling.

The coupling is of the rubber-bushing-and-pin type, similar to that used to couple motor-driven pumps, and the like, except that provision is made in the coupling to lift the generator rotor approximately $^3/_4$ in. without disturbing the PMG mounting, for generator thrust-bearing inspection.

The Permanent-Magnet Generator

Materials used in modern permanent magnets are of the alnico type. Laboratory tests have proved that alnico slugs, properly placed in a stator or rotor of the permanent-magnet generator, will not be weakened by short-circuit and other electrical faults that may occur in operation, nor will the removal of the rotor from the generator assembly affect the permanent magnets.

With the proper installation and design of the magnets, the stator windings, bearings, and coupling become the remaining elements most likely to require servicing.

The flyball-motor load is small and of a constant nature; therefore the permanent-magnet generator may be designed to operate continuously with low temperature rise, without exceeding practical over-all dimensions of the generator.

Generators of this type will operate for long periods of time without servicing.

The flexible coupling, through which the permanent-magnet-generator rotor is connected to the main generator, appears to be the weak link in this part of the equipment.

If the coupling is not centered properly, or if unequal wear occurs in the drive pins and bushings, a slight rate of change in angular rotation of the generator rotors will occur. A flyball sufficiently sensitive to respond accurately to 0.01 per cent change in speed will respond to this slight change in rotation of the PMG rotor, resulting in false movements of the flyball once per revolution of the turbine.

A permanent-magnet generator having its rotor directly attached to the main-generator shaft assembly, eliminating bearings and couplings, probably would be the most satisfactory design, in so far as reduction of maintenance to obtain continuous accuracy of flyball response to main-generator speed changes is concerned.

Both the conventional type of permanent-magnet

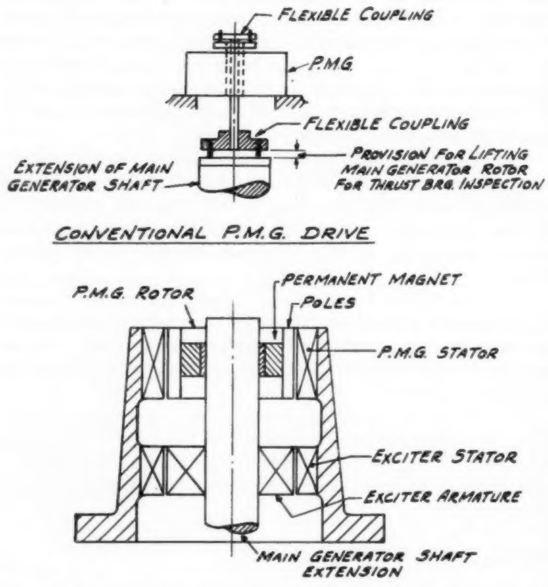

Fig. 3 Conventional permanent-magnet-generator drive and proposed method which eliminates bearings and flexible couplings

generator, with flexible coupling, and the suggested type of generator rotor attached directly to the main-generator shaft, which has been incorporated in some European designs, are illustrated in Fig. 3.

The Dashpot

The purpose of the dashpot is to provide adjustable means for controlling the rate at which energy is applied to the turbine, so that the energy will be applied at the same rate as the rate of acceleration or deceleration of the unit, thus preventing hunting or racing of the unit. The control of this rate of change of energy is accom-

plished by metering oil through an adjustable needle valve.

Modern system operation frequently requires the use of frequency or load controllers, which change the generator load, by sending electrical impulses to the speed-level motor in the governor mechanisms.

The rate of load change on the unit required for load or frequency control of the system is usually greater than the rate of load change permitted by the dashpot needle-valve adjustment, as required for off-line stability of the unit.

To prevent the impulses from becoming stored in a dashpot having its needle valve adjusted to provide for a small orifice for off-line stability, thus causing a delay in the required load change, a mechanical or solenoid-operated by-pass device is frequently provided in the dashpot.

The mechanically operated by-pass is actuated by turbine-gate position. The dashpot needle-valve adjustment, usually set rather tightly for off-line stability, will permit some speed-level motor impulses in either the load-on or the load-off direction to be stored in the dashpot. Load-on impulses stored in the dashpot before the by-pass is opened by gate position results in an annoying surge of the gates toward open position when the mechanical by-pass is opened. This surge is not experienced with the electrically operated by-pass if the solenoid control circuit is closed by an auxiliary switch activated by the main-generator breaker. The mechanical and electrically operated by-passes are illustrated in Fig. 4.

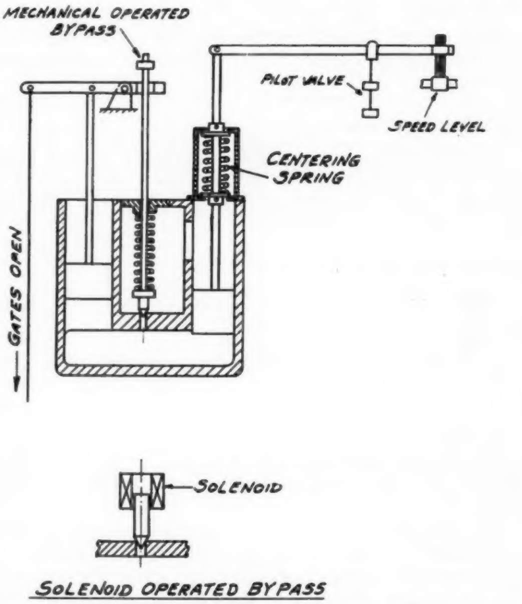

Fig. 4 Mechanical and solenoid-operated dashpot by-pass valves

Speed-Droop Mechanism

The speed-droop mechanism is an adjustable lever device, forming a mechanical link in the restoring mechanism between the wicket-gate servomotors and the governor floating-lever assembly.

The purpose of the speed-droop mechanism is to provide means of adjusting the amount of wicket-gate motion obtained from a unit of flyball speed change or change in speed-level position.

If the speed-droop mechanism is adjusted to zero, and assuming zero lap on the governor valves, very small sustained changes in system speed will cause the turbine servomotors to move and continue to move to the end of their stroke, because the servomotor motion will not restore the governor valves to mid-position.

If the speed-droop mechanism is adjusted to 5 per cent, a sustained system speed or flyball speed change of 5 per cent will be required to cause full stroke of the turbine servomotors.

It is obvious that equal or unequal division of loading between several generators per unit of system speed change may be obtained through the adjustment of the governor speed-droop mechanisms.

It is also obvious that the speed-droop mechanism must transmit servomotor motion to the governor floating-lever assembly very accurately.

Speed-Level Control

This device, like the speed-droop mechanism, is attached to the floating-lever system and used to position the governor valves.

Experience has demonstrated that a screw-and-nut type of mechanism, when properly designed, will position accurately the heavier more rigid type of floating-lever assembly, with infrequent maintenance requirements.

Speed-level-control motor circuits should be equipped with limit switches to prevent automatic electrical devices, such as automatic synchronizers, load controllers, and so on, from causing the speed-level mechanism from overrunning the normal operating range.

Gate-Limiting Device

The gate-limiting device, like the speed-level mechanism, is operated manually and also usually provided with a reversible direct-current motor for remote adjustment. This motor should have a higher torque rating than required, if long trouble-free service and accurate response to the actuating impulses are to be obtained.

The gate-limit device should be equipped with limit switches to prevent overtravel. Another limit switch, operated by the gate-limit mechanism, having its contacts connected into the speed-level-motor "raise" circuit, should be provided, to prevent the speed-level mechanism from overriding the gate-limit setting.

Relay Valve

The relay-valve bushing and relay-valve plunger should be designed with rigid sections to prevent distortion which would cause excessive wear and unsatisfactory operation.

The relay-valve casing also should be designed so that a reasonable amount of pipe strain will not be transmitted to the relay-valve bushing, causing distortion of the valve bushing.

Oil-Pressure System

The governor oil-pressure system is a very important part of the governor equipment. It is of the utmost importance to keep the system clean, for satisfactory per-

formance of the governor. This is particularly true in making the initial installation.

Piping

The shape of the fabricated sections of pipe frequently makes it difficult to store them at the project before installation; therefore, the pipe frequently is stacked outdoors, exposed to the elements.

The piping should be cleaned thoroughly, coated with protective material, and ends plugged, before shipment. Plugs and blind flanges must be attached securely to the ends of the pipe. If shipping schedules could be arranged so that the pipe and all governor components arrived at the project when they were required for installation, protective coatings which are easily removed could be used thereby saving considerable time in cleaning the pipe and governor parts before installation.

Ideal scheduling is usually not possible; therefore suitable equipment for cleaning the pipe and adequate storage for the governor should be provided by the contractor responsible for the installation.

Oil Pump

Governor oil pumps are usually of the screw or gear type. The screw-type pump is becoming more popular in this country. This type of pump may be operated at higher speeds than the gear pump, resulting in a smaller motor. Screw-type pumps are more expensive than gear pumps; however, the combined cost of pump and motor is frequently equal to, or less than, the combined cost of the gear-type pump-and-motor combination, because of the higher-speed less-expensive motor used with the screw-type pump. The screw-type pump does not require bearings, as the screws rotate within a cylinder, which acts as a bearing of low unit pressure, resulting in long service, with few, if any, maintenance requirements.

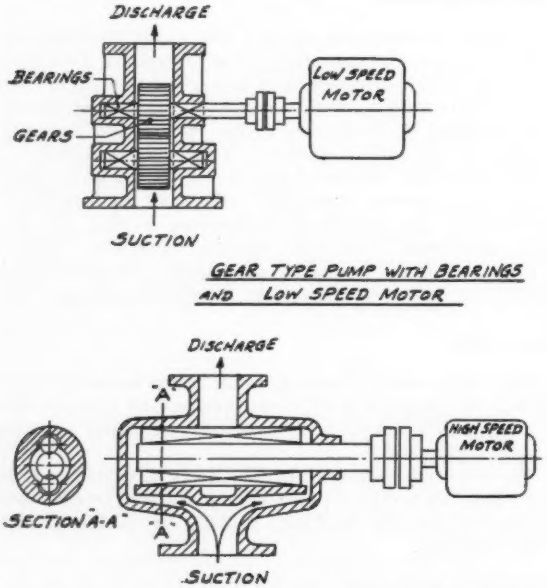

Fig. 5 Low-speed motor-driven gear-type pump, and high-speed screw-type pump

Unloader Valves

The unloader valves and relief valves frequently are built into the pump housing, forming a compact pumping unit, with a minimum of pipe joints to maintain.

Accumulator Tank

The accumulator tanks, like the piping, must be perfectly free of foreign substance when installed. These tanks are painted with an oil-resistant rust preventative on the inside; however, if they are stored outside, or in unheated buildings, for a period of time before installation, the surface may become damaged by condensation. It is essential to clean the interior of the tanks thoroughly before placing in operation.

Sump Tank

The sump tanks, like the accumulator tanks and piping, must be thoroughly clean before installation.

If one considers the ports of governor relay valve, pilot valves, and other hydraulic controls, as strainers, which, in normal operation, will pass foreign particles on the order of 0.002 in. or less, it is not difficult to visualize the destructive effect small particles of grit, sand, pipe scale, and even lint, will have on the performance of the governor, as well as the permanent damage to valve ports. The necessity of keeping the governor oil system clean cannot be stressed too much, if satisfactory governor operation is to be obtained with a minimum of maintenance.

Restoring Mechanism

The cable-type restoring mechanism has been used on practically all governor installations made in the past 10 years and is capable of operating for many years, with very little maintenance.

Position Indicators

Most governors are equipped with the following indicators:

1 Gate position and gate-limit position.
2 Speed droop.
3 Speed level.
4 Speed (tachometer).

Instruments having an accuracy of 1 per cent will give satisfactory performance for normal governor requirements.

The instruments should be equipped with permanently lubricated type ball bearings—stainless or bronze shafting, for resistance to corrosion, reducing the necessity of dismantling and cleaning the instruments.

Governor equipment of the foregoing type is more expensive than less rugged designs; however, the annual cost of maintenance on lighter equipment may well exceed the additional cost of more rigidly designed instruments.

Conclusion

The value of electrical energy lost when a generator unit is out of service, for maintenance of auxiliary equipment, may be equal to several times the value of the auxiliary equipment at fault.

This paper was written with the thought of presenting a few governor-design features, which, although adding slightly to the cost of the governor, will reduce outage time for governor maintenance.

Metallic Friction and Lubrication by Laminar Solids . . .

A Review of Current Theories[1]

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THE friction problem has been the subject of scientific investigation for centuries. Leonardo da Vinci knew that the frictional force was proportional to the applied load, and Amontons, in 1699, formulated the classical laws of friction. Yet even today, the mechanism of friction is not clearly understood. This review contains a discussion of present knowledge of metallic friction as well as a discussion of the basic mechanism of laminar solid lubrication.

Contrary to popular belief, friction is a complicated phenomenon. Part of the complexity becomes evident if one examines so-called "smooth" surfaces under a microscope. Even the highest finishes obtainable consist of hills and hollows about 100–1000 Å in height (1).[2] The asperities or high points support the load, and the actual area of contact is only a small portion of the geometric area. The problem is made complicated by the fact that surfaces are not clean; i.e., the surfaces may contain adsorbed vapors, oxides, sulphides or chlorides of the metal, or other impurity atoms. These will have a pronounced effect on the friction force and, in fact, are responsible for much of the difficulty in obtaining reproducible experimental results. Further complications are introduced by the work-hardening of the surfaces due to sliding, which changes the physical properties of the contacting surfaces.

Laws of Friction

The classical laws of friction were noted by Amontons (1699) and experimentally confirmed by Coulomb (1785) and Morin (1831). These laws may be stated as follows (2):

1 The frictional resistance is proportional to the load.
2 The frictional resistance is independent of the geometrical area of contact.
3 The frictional resistance is independent of the velocity of sliding.
4 The coefficient of friction depends on the materials in contact.

The new view (Holm, Bowden, Finch, et al.) (1, 3, 4), based on research during the past twenty years, leads to the conclusion that only the second and fourth laws are valid. The new laws may be written (2):

1 The frictional resistance is proportional to the actual area of contact (which, as will be shown, is a function of load).
2 The frictional resistance is independent of the geometrical area.
3 The frictional resistance depends on the velocity, but is nearly constant over a wide range of velocities.
4 The coefficient of friction depends on the materials in contact.

The new view has won many adherents but champions of the older theory remain much in evidence (5, 6). Feng (7) has recently introduced a modification of the newer "weld" theory which is capable of explaining wear in a more direct manner. In addition, there is a molecular theory, proposed by Tomlinson (8), in which the frictional force arises from the interaction of molecular fields. All of these views are described and discussed in the sections that follow. A theory which asserts that friction is of an electrostatic nature has been proposed (9) but there is little evidence to confirm this view.

Theories of Friction

The coefficient of friction is defined as the ratio of the frictional force F to the normal load W, where the frictional force is either of two quantities: (*a*) The force necessary to initiate sliding—for static coefficient; (*b*) the force necessary to maintain sliding at a constant velocity—for kinetic coefficient.

Experimentally, the coefficient of friction of dry surfaces is independent of the load and the geometric area of contact. This has been explained in three ways which will be discussed in some detail.

The Weld Theory

According to this view, friction is due primarily to the cold-welding of surfaces when they are brought together under load. The principal points of the theory may be explained as follows: When two surfaces are in contact under a load W, the load is not carried by the geometric surface, but by the contacting high points, as seen in Fig. 1. If the load pressure at the contact exceeds the flow pressure of one of the contacting metals, plastic flow will ensue until the area of contact is able to support the load without further flow. Then the total area of contact is given by

$$A = W/p_m \qquad [1]$$

where p_m is the flow pressure. Now for sliding to occur, or to continue, the welded contacts must be sheared, or shearing must occur in the bulk of the softer metal. The shear force required is proportional to the area of contact

$$F = As \qquad [2]$$

[1] This work supported by the Office of Ordnance Research, U. S. Army under Contract No. DA-23-072-ORD-768.

[2] Numbers in parentheses refer to the Bibliography at the end of the paper.

where s is the smallest shear strength (either at the contact surface or within the bulk metal). Then the coefficient of friction μ is given by

$$\mu = F/W = s/p_m \ldots\ldots\ldots\ldots\ldots [3]$$

The weld force is believed to be the primary cause of friction between unlubricated surfaces.

In addition to the weld force, Bowden and Tabor

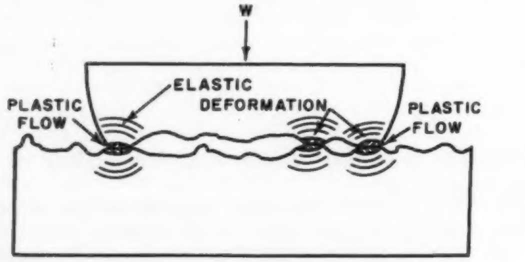

Fig. 1 Two solids placed in contact are supported on summits of surface irregularities. Pressure exceeds yield pressure p_m of solid, which flows plastically until area of contact A is sufficient to support load W; hence $A = W/p_m$. Material around regions of contact will be deformed elastically, reference (13).

(10) have taken into account the effects of ploughing by surface asperities by writing the frictional force F as

$$F = As + A'p' \ldots\ldots\ldots\ldots\ldots [4]$$

where $A'p'$ represents the force required to shear out an area of cross section A'. In most cases the ploughing term is much smaller than the shear term and may be ignored. It is to be noted that ploughing is a different phenomenon from metal transfer which is due to shear in the bulk metal. Ploughing may be defined as the gouging of a surface by a hardened surface asperity.

Bowden asserts that the region behind the weld is one of elastic deformation. When the load is reduced or relieved there is an elastic recovery force which may weaken or break the welded joint. In this way it is possible to explain the differences in the frictional behavior of soft metals (e.g., indium) and hard metals (e.g., steel).

The Interlock-Weld Theory

Feng (7) asserts that if the weld theory is to explain wear, it must be modified to the following extent: When two surfaces are brought into close contact under a load, the surfaces are roughened and, in fact, interlock, Fig. 2. If the surfaces are clean (pure metals baked out in vacuum, for example) or if the surface film is weak, welding will occur, Fig. 3. If the surface coating can deform and retain its continuity, then the interlocked surfaces will not weld readily. However, in either case, shear will take place if a tangential force is applied and, as in the weld theory, shear will occur in the softer metal, yielding the same equation for μ. The shearing action will produce wear particles if there is no welding, and will produce metal transfer if the weld strength is sufficient. An interesting relationship results from this theory when all parameters (load, work-hardening, and so on) except the surrounding atmosphere are kept constant. Then[3]

$$\text{wear} + \text{transfer} = \text{const}$$

[3] Private communication from I-Ming Feng.

Essentially, variation of the atmosphere varies the "weld insulation."

The Asperity Theory

Coulomb Theory (5). Coulomb proposed that friction was due to the roughness of the sliding surfaces and represented the work necessary to lift the load over the asperities. This may be explained in the following manner:

When a slider slides on a support, the hills of the slider surface must ride over the hills of the support. The hills are deformed repeatedly and some common slope is established. Sliding consists of the alternate lifting and falling of the slider. If θ is the angle formed by the slope and the support, the component of the tangential force F which acts along the slope is $F \cos \theta$. The component of the applied load W acting along the slope is $W \sin \theta$. If there is no acceleration, then

$$F \cos \theta = W \sin \theta \ldots\ldots\ldots\ldots\ldots [5]$$

and the coefficient of friction μ is

$$\mu = F/W = \tan \theta \ldots\ldots\ldots\ldots\ldots [6]$$

The coefficient of friction, for most materials, lies between 0.1 and 0.5 and thus θ is a small angle (between 6 and 26°). It is shown later that this range of μ suggested

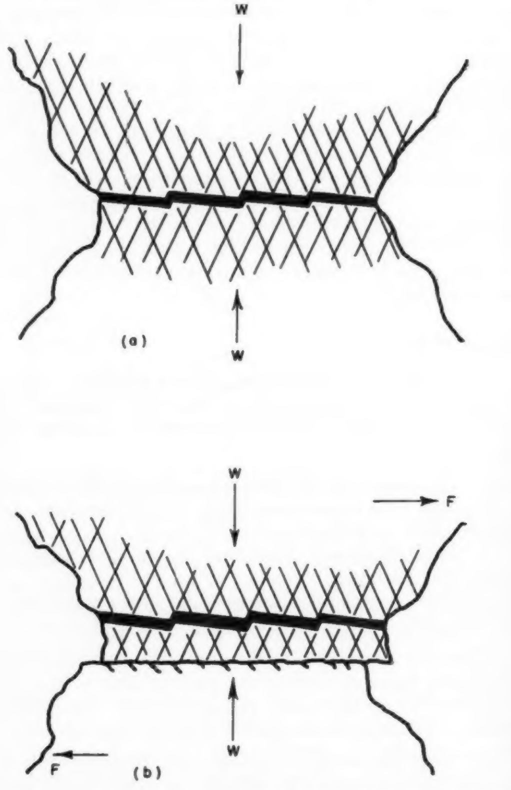

Fig. 2 (*a*) Sketch showing roughened interface of a pair of actually contacting high spots as a result of plastic deformation. (*b*) Sketch showing that mechanical interlocking effect of roughened interface offers great resistance to tangential force and that breakage occurs along weakest section rather than original interface, reference (7).

by Bikerman, reference (5), is not the range observed). In this theory the coefficient of friction should depend on the degree of surface finish or roughness of the sliding surfaces.

The Molecular Theory

Tomlinson (8) has proposed a "molecular theory" of friction, which attributes friction to the atomic fields of the surface atoms. When two surfaces are in intimate contact under load, the atoms of one material are forced into the atomic fields of the other. At sufficiently small distances of approach, the atomic forces become attractive. In sliding, the atoms are separated so as to exert a "plucking" action with a resultant loss of energy. The energy lost, which goes into thermal energy, is exhibited as friction.

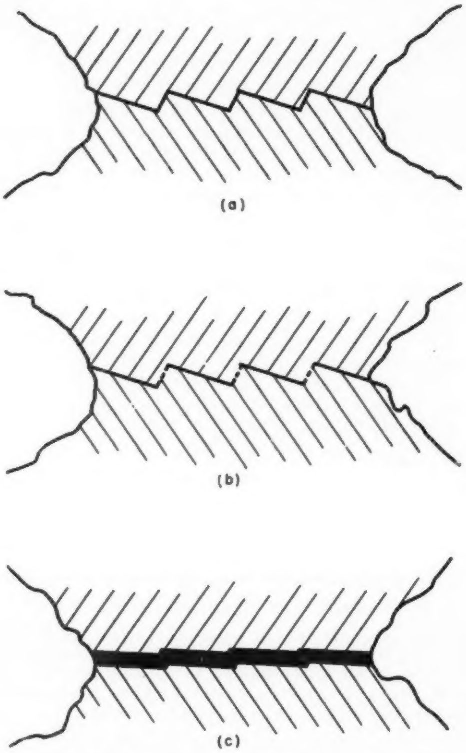

Fig. 3 Sketch showing roughened interface of pair of actually contacting high spots with contaminated surfaces. (*a*) For case that surface film is tenacious, and thin as compared to average roughening of interface. (*b*) Same as (*a*) except that surface film is brittle. Establishment of metal-to-metal contact on regions shown by dotted lines is possible. (*c*) For case that thickness of surface film is close to or greater than average depth of roughening of interface, reference (7).

This theory cannot account for the large wear particles (11) and the welds (12 and 13) observed in friction experiments, for this theory requires that interactions occur only between the surface atoms. However, depending on surface conditions, the surrounding atmosphere, operating temperature, and loading, a greater or lesser proportion of the friction force may be due to contacts in which no weld occurs and in which the atomic forces described by Tomlinson may play the dominant role.

Discussion of the Theories

In all the theories mentioned here the coefficient of friction is independent of the area of contact, although the dependence of the frictional force on the area is different. The wealth of information available at present makes it possible to examine the theories more closely, to see to what extent they are confirmed or denied. Let us first analyze the experimental measurements of the coefficient of friction of different materials and for various degrees of finish.

Coefficient of Friction

Bowden and Young (14) have measured the coefficients of friction for clean metals (degassed in vacuum). The values obtained generally lie between 1 and 5, while a few metals give even higher coefficients ($\sim$10). This would require unreasonably large values of θ, which is a measure of surface roughness. For some oxidized metals μ is as large as 1 even in ordinary atmosphere, requiring $\theta \simeq 45$ deg even when these surfaces are highly finished.

The relation between the coefficient of friction of oxidized surfaces and the load has been interpreted in terms of the ability of the oxide to deform when the metal substrate flows, as illustrated in Fig. 3.

Fig. 4 shows the coefficients of friction of copper, tin,

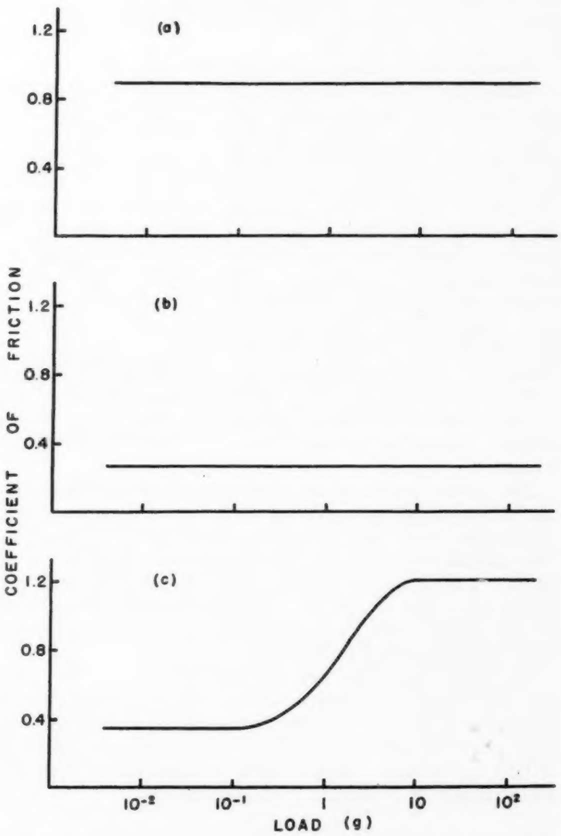

Fig. 4 Coefficient of friction as function of load; (*a*) for tin sliding on tin; (*b*) chromium on chromium; (*c*) copper on copper, reference (15)

and chromium as functions of load (15). Tin oxide, being brittle and much harder than tin, breaks down under the lightest loads and metallic adhesion occurs. Copper oxide can support small loads but breaks down under large loads; thus at light loads the coefficient of friction is characteristic of copper oxide sliding on copper oxide, while at heavy loads μ is characteristic of clean copper surfaces. Chromium does not flow readily, and the oxide can deform with the chromium substrate for the highest loads measured.

It has been shown that the coefficient of friction is independent of surface roughness over a large range of finishes (16). This would favor the weld theory over the asperity theory, for the weld theory infers that for rough surfaces there will be few contacts, but the total contact area will be the same as for finer finishes. There is no difference between the interlock-weld theory and the weld theory on these points.

Some additional verification of the weld theory comes from a study of the actual area of contact as a function of load. Recent experimental data (17) indicate that the contact area is almost independent of the geometric area, and depends primarily on the load. Estimates of the contact area from the flow pressure and by visual observations (examination of the surface under a microscope) are in good agreement with measurements of contact resistance (18). All data indicate that the contact area is a linear function of the load.

The weld theory is strengthened considerably by the radiographic experiments of Rabinowicz and Tabor (12). It is inherent in the weld theory that metal be transferred from one sliding surface to the other. That such is actually the case was verified experimentally by Rabinowicz and Tabor using radioactive materials and photographic plates. Initially in their experiments, only one of a pair of sliding surfaces was radioactive. After sliding had occurred, radioactivity was found on the other surface, photographic plates being used for detection.

The values of the shear strength calculated from the coefficient of friction (using Equation [3]) are in fair agreement with the values observed for bulk metals. The calculated values are generally larger (by a factor of less than 2) than the bulk values. The difference is believed to be due to the fact that the friction surfaces are work-hardened by sliding. This, too, favors the weld (and weld-interlock) theory.

Ernst and Merchant (19) calculated the shear strength by considering shear as a one-dimensional melting. Then, using the available data on the values of the yield pressure, they obtained values of μ in reasonable agreement with experiment. Their results are consistent with the weld theory as expressed by Equation [3].

Adhesion

The weld theory implies that if a weld is formed under load, a force (of the order of magnitude of the load) should be required to separate the surfaces when the load is removed. (The weld-interlock theory has the same implications for clean or nearly clean surfaces.) Hardy (20), who predicted the existence of an "adhesion" force, was unable to detect any measurable adhesion. More recently, however, McFarlane and Tabor (21) have measured the adhesion force as a function of load for several metals sliding on indium. Using von Mises' criterion (22), they find that for steel on indium the coefficient of adhesion σ is related to the coefficient of friction μ by the equation

$$\mu^2 = 0.3(\sigma^2 - 1) \qquad [7]$$

where σ is defined as the ratio of the force to separate the contacts divided by the load originally applied to form the weld. Fig. 5 shows the agreement between theory and experiment.

Little or no adhesion was observed for metals harder than indium. This can be explained by a study of Fig. 1. Behind the plastic-flow region there exists a region of elastic deformation. For the harder metals, the stored elastic energy is sufficient to weaken or break the bond when the elastic stress is released (the load is removed).

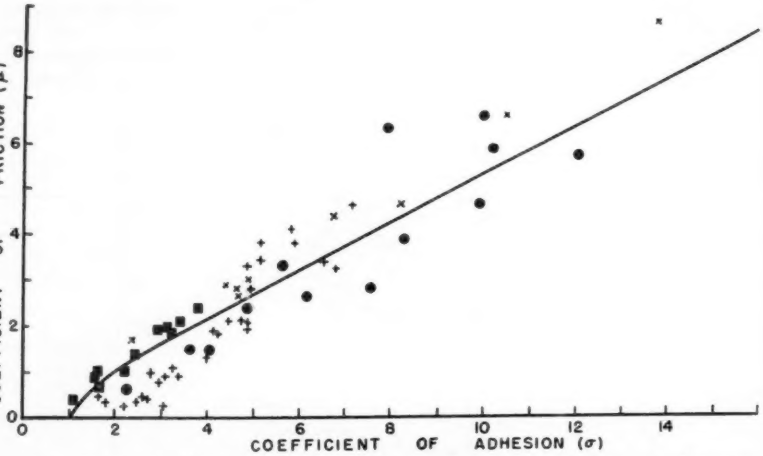

Fig. 5 Coefficient of friction (μ) and coefficient of adhesion (σ) for steel sliding on indium as relative motion takes place between surfaces. Experimental points are for loads: ● 5.9 g; + 14.5 g; ■ 100 g; x various other loads. Continuous line is theoretical curve (McFarlane and Tabor, 1950). It is seen that coefficient of friction is of same order of magnitude as coefficient of adhesion, reference (13).

In soft metals, such as indium, the elastic recovery forces are weak and the weld holds (23).

The existence of the adhesive force also has been confirmed by Bowden and Young (14, 24). They studied clean surfaces degassed in vacuum and observed adhesive forces. The presence of surface layers of oxides, adsorbed vapors and/or other impurities reduced the adhesion. Feng's theory would predict the same behavior as the weld theory except in the fine details of the behavior of the contact points (i.e., the manner in which the junction deforms). Fig. 3 describes the various cases in which surface layers affect the adhesion. The asperity theory cannot account for the adhesion of surfaces under load.

Wear

Wear can be described as the total loss of weight or mass of the sliding surfaces which accompanies friction. This is not to be confused with transfer, which refers to

the transfer of metal from one sliding surface to another. The weld theory would attribute wear to the gouging or ploughing component of friction. The shear of welds accounts for wear of one of the metals (transfer) but does not account for the formation of wear particles. Feng's theory, however, accounts for the formation of wear particles by asserting that roughened surfaces do not always weld. The asperity theory can only account for wear particles as arising from occasional gouging.

Archard (25) has examined the problem of wear by assuming the removal of lumps formed by the plastic deformation at contact areas. He assumes that a fraction of the contacts will shear and become wear particles, without examining in detail the process by which wear particles are formed. Rabinowicz (26), by studying the size distribution of wear and transfer particles by autoradiographic techniques and applying Archard's reasoning, has developed a technique for the quantitative analysis of the "wear" process.[4] He assumes that the fraction of the contacts which become wear particles is independent of the size of the individual contacts. The fraction is, experimentally, independent of the load. The contact area increases with load, and wear then increases with load. Rabinowicz's method can be used to find the relation between wear and transfer by making a radiograph after sliding, and another after cleaning to remove the wear particles. Thus any difference in amount and in size distribution of wear and transfer particles can be noted.

Generally, wear increases with load. Barwell and Strang (27) have found that when the area of contact is so large that wear particles cannot be removed, then the rate of wear increases sharply. This is similar to the explanation of fretting corrosion proposed by Feng (11, 28). The Feng (interlock-weld) theory appears to provide the best explanation of wear.

Lubrication

The effect of a lubricant is to separate the sliding surfaces so that there is no (or little) metallic contact. The field of fluid (hydrodynamic) lubrication has been studied extensively and will not be discussed here. (By fluid lubrication is meant that the lubricant layer is so thick that no metallic contact can occur.) Boundary lubrication, or lubrication by very thin lubricant films, is of greater interest because, when boundary lubrication breaks down, heavy wear follows and the sliding surfaces may suffer a great deal of damage.

Good boundary lubricants will reduce the coefficient of friction between sliding surfaces and reduce wear and transfer. However, the effect on wear is generally more drastic than the reduction in the coefficient of friction. For example, a lubricant which reduces μ by a factor of 20 may reduce the wear by a factor of 20,000 (12, 29). Lubricants reduce the adhesion between surfaces in much the same manner as do oxides or adsorbed vapors. The reader is referred to Bowden and Tabor (30) for a complete treatment of boundary lubrication.

Another type of lubrication, lubrication by laminar solids, has become important in recent years. This is discussed in a following section.

[4] Rabinowicz does not distinguish wear from transfer and lumps both effects in the term wear.

Other Factors

A few words about the influence of temperature and sliding velocity on the coefficient of friction are in order. In general, the coefficient of friction is independent of the temperature over a wide range of temperatures. At temperatures near the melting point of one of the surfaces the coefficient of friction falls rapidly. This has been explained as the result of the low shear strength of the liquid-metal film which occurs at local regions of high temperature. Hot spots have been observed during sliding. The phenomenon of "stick-slip" (31, 32, 33) which is observed under some conditions is also related to melting of local regions.

Parenthetically, some interesting observations by Umeda and Nakano may be noted (34). They found that when the sliding metals are different, the coefficient of friction varies with temperature in the same way as the solid solubility. This has been explained as being due primarily to the effect on the melting point of contact areas by alloying of the surface layers of the sliding surfaces. The coefficient of friction, in general, depends on the sliding velocity. The behavior may be listed in the following manner (35).

1 At very low speeds there are examples of frictional force both increasing and decreasing with speed.

2 At medium speeds (1 ips to a few fps), frictional force is nearly independent of speed.

3 At high speeds, frictional force decreases with speed (36).

The frictional behavior at low speeds is critical in many cases because of the occurrence of stick-slip. This phenomenon usually will be observed when the static coefficient of friction is greater than the kinetic coefficient and when one sliding member is elastically supported. The motion then proceeds by alternate seizures and breaks.

Coulomb was not aware of these facts because his measurements were made at medium speeds. This behavior has not been explained clearly, but the decrease of the coefficient of friction at high speeds may be related to the inability of the contacts to weld when the "contact time" (time that two discrete asperities touch) is short. The behavior at low speeds may be due to the viscous nature of shear. The problem of the velocity dependence of friction is worthy of more attention than it has received in the past.

Laminar Solid Lubricants

Graphite has been used as a lubricant for many years; more recently molybdenite (MoS_2) has found many uses as a low-friction lubricant. These solid lubricants have the ability to maintain good lubrication properties under extreme conditions. The excellent lubrication properties of graphite and molybdenite were believed to be due to the laminar structure of these materials. Both graphite and MoS_2 have a hexagonal structure with a large separation between adjacent (0001) planes, adjacent S ions in MoS_2, reference (37). The weakness of the bonding between adjacent (0001) planes was believed to be responsible for the lubrication properties of these lamellar materials. Savage (38) found that graphite lubrication breaks down at very low pressures but the lubrication properties can be restored by adding a small amount of water vapor. The mechanism by which water vapor affects the lubrication properties is not understood, but

the fact that water (or other adsorbed vapors) is necessary for good lubrication in graphite has been firmly established.

MoS_2 maintains its lubrication properties at very low pressures but some experimental work indicates that MoS_2 may retain adsorbed water vapor in vacuum in measurable amounts (39). Further, recent experiments indicate that large quantities of water destroy, in part, the lubrication properties of MoS_2 (40). Only a small part of the effect appears to be due to the corrosion produced by an acid resulting from MoS_2–H_2O interaction.

X-ray diffraction studies of surfaces lubricated with MoS_2 (41) powder, and electron diffraction studies of surfaces lubricated with graphite powder (42) show that the lubricating particles lie with the lamellae parallel to the sliding surfaces when the sliding is characterized by low friction and little wear. For MoS_2, powder lubrication is better than that obtained when MoS_2 is bound to the surface (corn syrup, resin, or perspex as binding material), applied in pellets or formed from a molybdenized surface. Good lubrication properties also are obtained when MoS_2 is applied to a phosphated surface. The results for graphite are similar. Feng has tabulated the coefficients of friction obtained for graphite and MoS_2 for the various methods of application of the lubricant (41). It would appear that both graphite and MoS_2 display their optimum lubrication properties when the particles can move about or deform so that the lamellae are parallel to the sliding surfaces. The effects of adsorbed vapors on the orientation mechanism should be investigated further.

Fullam and Savage (43) suggest that graphite crystallites do not lie flat, but overlap slightly, like a smoothed-out deck of cards, in the direction of motion. The evidence for this (electron-micrograph studies of a replica of the surface) is not too conclusive, but Savage's work on the friction of large graphite crystals (44) indicates that a small slope of the lamellae is required for a low friction coefficient. There is no evidence of this behavior in MoS_2.

Some other solid lubricants may be mentioned. These are plastic organic compounds rather than laminar crystals. The plastic polytetrafluoroethylene (PTFE) has excellent lubrication properties (45). It is a poor thermal conductor and has a high coefficient of expansion which limits its usefulness as a lubricant. However, if PTFE is used to impregnate sintered copper, one obtains effective and long-lasting lubrication (46).

The present status of our knowledge of MoS_2 and graphite lubrication is summarized in the following.

Coefficient of Friction

The coefficient of friction for hard steel sliding on hard steel is 0.09–0.20 for graphite lubrication and 0.05–0.20 for molybdenite lubrication. The wide range of values is due to the various methods of application. For example, for lubricant films rubbed on SAE 1020 steel the coefficient of friction is 0.11–0.14 for graphite and 0.05–0.095 for MoS_2 (41). The values given are for room temperature and atmospheric pressure. The "lubricant wear" and time of effective lubrication depend on the method of applying the lubricant. An increase in film life is obtained when graphite is bonded to the surface with a resin. Campbell (47) reports that there is an optimum graphite percentage which gives the longest film life. Above and below this optimum value ($\sim$20 per cent graphite by volume) film life decreases rapidly.

Effects of Atmosphere and Temperature

The fact that graphite loses its lubricating properties in the absence of condensable vapors has been firmly established (38). In vacuum or dry atmospheres high friction is accompanied by heavy wear. MoS_2 has been used as a lubricant in vacuum and its performance is little affected; in fact, it is used as a lubricant in rotating target x-ray tubes. There is evidence that MoS_2 readsorbs vapors (39), but no change of frictional properties has been detected for vacuum conditions, at least down to pressures at which graphite lubrication breaks down.

Peterson and Johnson (40) have examined MoS_2 lubrication at high humidity and also in the presence of water. The results show an increase in the coefficient of friction when the relative humidity is greater than 6 to 10 per cent. At very high relative humidities (>75 per cent) the coefficient of friction decreases to values lower than those obtained at humidities of 50 to 60 per cent. However, these high-humidity results are somewhat erratic. Corrosion may play a small role in the loss of lubrication characteristics (MoS_2 produces an acid in the presence of water) but is not the major factor. No comparable experiments have been performed with graphite, but it is doubtful that the effect is important, since graphite brushes are effective in humid atmospheres.

Neither graphite nor MoS_2 melts under normal pressures. The sublimation temperature of graphite is greater than 3500 C (6300 F) and no melting has been observed with MoS_2 heated to 1427 C (2600 F). MoS_2 decomposes in vacuum at high temperatures yielding metallic molybdenum and free sulphur. MoS_2 oxidizes at temperatures greater than 400 C (750 F) and the oxidation products do not have good lubrication properties; molybdenum oxide is abrasive; sulphur is corrosive (36).

Feng (41) suggests that MoS_2 should not be used at high temperatures (>750 F). Graphite oxidizes at 450 C (842 F) but its oxidation products are not corrosive. Because of the dependence of lubrication properties upon adsorption films one would expect graphite to be a less effective lubricant than MoS_2. However, the lack of abrasive products makes graphite preferable to MoS_2 at high temperatures.

Effects of Crystallographic Orientation

The laminar structure of graphite and MoS_2 leads one to expect a dependence of friction properties on the orientation of the particles (crystallites). Feng (41) reports a friction coefficient of 0.10 for a single crystal of MoS_2 sliding along the cleavage surface; with the edges of the cleavage surface sliding along the same substrate the coefficient of friction was at least 0.26. The results for graphite (42) are similar, but wear, rather than friction, was measured in dry atmospheres. X-ray diffraction studies of MoS_2 surfaces before and after sliding show that the crystals are strongly oriented after sliding, with the cleavage plane (0001) parallel to the sliding surfaces; before sliding there is some ordering of the lamellae (MoS_2 rubbed with cotton). Godfrey and Bisson (48) report no ordering of powdered MoS_2 on steel.

Electron diffraction studies of graphite (42) show that, when little wear occurs, the cleavage plane is parallel to the sliding surfaces; when there is heavy wear, the cleavage planes are randomly oriented. Further, graphite surfaces which have been sliding in the no-wear condition (and hence are oriented) are not affected when

the moisture is removed from the atmosphere. All these experiments indicate a strong correlation of the "parameters"—orientation, vapor concentration, wear, and friction.

The role that vapor plays in the bonding of lubricants to the substrate, or in assisting shear, is not known. Campbell and Kozak (42) suggest that the water molecules reduce the shearing force in the cleavage plane, but this has not been confirmed. They further suggest that the degree of orientation is a function of the hardness of the sliding surfaces. Experiments on single crystals of graphite (lamellae are visibly observed) by Savage (44) indicate that for effective lubrication the lamellae make a small angle (<5 deg) with the sliding surfaces.

Effects of Sliding Speed

Bisson (36) has studied the effect of sliding speed on the coefficient of friction. The coefficient of friction of graphite increases slowly with an increase in sliding speed, while the coefficient of friction of MoS_2 decreases when the sliding speed is increased. The changes in μ are small but they are, no doubt, significant. The increase in the coefficient of friction of graphite may be due to the fact that the increase in temperature at high sliding velocities causes evaporation of water molecules and thus induces dry atmosphere behavior. This also may explain, in part, the decrease in the coefficient of friction of MoS_2. The role of oxidation products at high sliding velocities is not yet fully understood.

Summary

It is evident that the current theories, while useful, are of limited validity. The modern usage of bearings under conditions of high speeds, high temperatures, and heavy loads requires a more complete understanding of the nature of friction. Recent experimental work has contributed greatly toward a better understanding of friction, but many still obscure factors of the fundamental process provide a fruitful field of research.

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Operations Research

. . . Its Relation to Production Engineering

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Originally developed to cope with the myriad problems of war, the techniques of operations research are now beginning to be applied to industry. After defining operations research, this paper develops its scope, organizational objectives, and economy, as contrasted with production engineering. The present and possible future relationships of the two functions are delineated.

Operations research involves research by use of the methodology of science with the ultimate goal of comprehension of the relationships among the underlying causal factors and phenomena associated with the process under study. And to many who profess to have done or to be doing operations research the term methodology of science is restrictive in the sense that the physical sciences are understood. Quite logically, a quantitatively formulated framework or model would therefore represent the objective of the research. To the engineer this is a highly desirable and certainly not novel objective. The method in more detail would involve the familiar steps of problem definition; definition of terms and measures; determination of facts; construction of the hypothesis or explanation by empirical, logical, or intuitive means; and final testing of conclusions. This procedure in itself should not seem new to the engineer whose training involves the fundamentals of physical science, although some of the newer techniques may be unfamiliar.

Operations in industry involve people, procedures, decision, and usually equipment, whether the production, distribution, control, or design functions are being studied. Complex relationships abound, and it is not illogical that a variety of disciplines have been able to make a contribution in the solution of some of the problems met, thus lending emphasis to the well-publicized point that team research is frequently necessary in tackling such problems effectively.

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Contrast With Production Engineering

Repeatedly, engineers such as production, industrial, or management engineers who are involved with processes or operations come to the conclusion, after reading about operations research, that what they are doing is truly operations research. And in most cases this conclusion is probably false when judged upon three bases which are pertinent. These are the degree of organizational restriction, the degree of economic restriction, and the technique and methodological resources. Only infrequently are production engineers doing operations research incidental to the execution of their primary function.

Production-Engineer's Function. The production-engineer's function is principally one of design of the production system, and it is executed under restrictions which the engineer may regard as inherent. These restrictions when considered in conjunction with the design function help to distinguish engineering from science. To some degree for research it is essential to remove these restrictions of time, of limit of expenditure, of breadth of technique, and of scope of the field of study. The engineer would regard this freedom as quite unusual.

Some limitations in the scope of any operational study are nevertheless inherent, and it is therefore difficult to demonstrate a distinction between production engineering and operations research on this ground alone, since the difference is one of degree. Nevertheless, some characteristics of the normal environment of production engineering are worth emphasis.

The usual organizational structure of a manufacturing firm when combined with a typical budgetary-control system results in the development of artificial measures of performance against which individual units of the organization are judged. These criteria are frequently such that the engineer is forced into a narrow range of operation. In addition the function is frequently under control of supervision guided by very narrow and short-range objectives, as for example those of the production manager who is in the main concerned with current and immediate emergencies rather than optimal solutions to his problems over time. As a result, by a process of organizational evolution, the performance of the manager and his organization has come to be judged against a set of values which may be quite inconsistent with the over-all optimization presumably the firm's objective.

If it is assumed that the organizational and policy barriers can be lifted, the production engineer will usually be found blocked by economic factors. Generally production engineering is underfinanced. The type of analysis and investigation involved in operations

research is expensive in relation to the existent situation and is usually not found outside of the laboratory. Few production-engineering departments in order to do research can afford to detach the manpower, retain necessary consulting assistance, and embark upon essential data collection and resultant computational expenditures.

Scientific Training Necessary. Despite these obstacles, many engineers do succeed in attacking some of the complex problems of industrial operations. In these instances the contrast between their methods and those of operations research must be based on the methodological approach used. The requirements are training in the fundamentals of science, which many engineers have received, supplemented by subsequent training and experience directed toward development of ability as a scientist from the viewpoint of the use of the scientific method. It seems quite doubtful that many engineers have received this latter training and experience, and even less likely that those who have are found in the ranks of production engineering.

Techniques for Research. Any generalization with respect to techniques for research is dangerous; yet enough is known of the types of data available and necessary to deal with such problems as those of layout, handling, equipment utilization, and others, to state that proper statistical training (not supplied by a short course of one or two weeks) is necessary. Also essential are better data-collection and computational devices than are ordinarily available to the engineer. The process of attempted optimization of various design and production alternatives and test of the proposals against varying possibilities are important and essential techniques in the research methodology involved in production-engineering problems.

From the foregoing, the statement follows that the criteria of good operations research are ability to overcome organizational obstacles and to exercise freedom of action, ability to obtain adequate economic resources, proficiency in the scientific method, and competence in or access to necessary specialized statistical and computational and testing methods.

Contrast of Viewpoints and Objectives

The most important difference in viewpoint between the production engineer and one involved in research is that the former generally asks first the question, "Will it work?"—whereas the latter asks, "Why does it behave in this fashion?" These questions well illustrate the differences in mental process, function, training, and environment.

Perhaps the variation in objectives is presented adequately by comparing science and engineering. Optimally, operations research is science and takes place as scientific research with the implication of the steps of pursuit of facts, development of hypotheses, prediction, and testing of results, regardless of where the path leads. On the other hand production engineering involves the engineering steps of design, innovation, or intuitive development of a process under conditions of limited time, money, and resources. The prime test of the success of research is one of validity, completeness, and logic whereas the prime test of success in the production-engineering function is one of relatively economic and safe functioning achieved within a time limitation.

A Hypothetical Example

For comparison of methods, let us assume the problem to be the layout of a plant to manufacture a particular line of products. The production-engineering steps include product analysis for manufacture; determination of the sequence and detailed processing steps by which the product is to be made; development of any new processes and methods where required; estimation of time and quantity factors; selection of equipment and design of manufacturing layout, tooling, gaging, and inspection methods; handling and flow procedures; cost estimation, and many other steps depending on industry, firm, and product. Generally these will be completed to the best ability of the individual engineers and the group. Specialists in various aspects of manufacturing such as tool design, handling, work measurement, processing, layout, and so on, will be involved and the co-operative effort will be evaluated in terms of cost to manufacture by labor, material, and some measure of investment and overhead. If the investment is too high or cost is too great, based on previous experience or knowledge of competition, more effort may be devoted to the problem. Otherwise the fact that a way to manufacture the product line successfully has been designed is sufficient.

Operations-Research Approach. Without implying that operations research can substitute for technical and design competence, one can state that some of the steps in the process would be approached quite differently were the opportunity offered. One is the original definition of the problem in which such factors as volume are considered. Here is called for rather searching inquiry as to variation, accuracy, significance, and trends of volume and mix data. That this involves organizational entities and concepts outside of normal production-engineering responsibility is evident. The results are important to insure a design most susceptible to the type of control needed as well as in the method of testing the completed design to evaluate optimal performance. The data and estimated times for determination of machine grouping and line balancing would be handled differently and methods of computation which recognize the inherent variation would be utilized.

Before completing the layout, in all likelihood the operations-research group would attempt to determine if optimal results are obtained. This would involve development of measures quantitatively related to design parameters to indicate possible accomplishment. In addition some sort of testing or "gaming" would be resorted to in order to determine the response of the layout to various conditions of volume and product mix. This would include both those which are likely and the unlikely extremes, thus obtaining some impression of critical limits and parameters.

To some extent individual engineers are working along these lines here and there in production engineering. Still this is not general as yet.

Security Limitations

A considerable number of mathematical developments and derived techniques have come about during the past decade, many under security limitations, which evidently have not been assimilated by practicing engineers who might find them useful. Obviously these techniques were not available when many of the currently employed methods of industrial and production engineering were developed. It is therefore to be ex-

pected that those who attack the same problems with the incremental advantage of more powerful methods will develop different and probably improved techniques of solution.

Since the days of Taylor and his contemporaries, it is amazing how little true research on operations has taken place. It is hypothesized that this was not the result of a lack of capable people or interest in the problem but more likely due to inability to handle the complex interactions and multivariate problems involved as well as lack of means of collecting and processing data in the volume necessary. Great progress in overcoming these obstacles has been made in recent years largely as a result of mathematical and statistical developments in conjunction with work on economical mass-data handling and computational devices. It appears inevitable that improvements in the techniques of the industrial engineer or production engineer will follow, and we are left with the problem of expediting this.

Classified Techniques. The techniques referred to are being used in military operations research and presumably are being developed further. A problem exists in the transferral of any new development to practice, and when a development which takes place under the sponsorship of one discipline, such as statistical mathematics, is of use to a different one in specialized applications, such as production engineering, this problem is intensified. Assuming that the developments of interest to us are refined and applied under the guise of classified military or commercial operations research by groups of individuals of varying backgrounds and training, the engineer has cause to be concerned about the dissemination of such knowledge. Obviously, the creation of the Operations Research Society of America and its Journal provides a forum for interchange in the field and, to the extent that results are published, an opportunity for the engineer to become familiar with the concepts and techniques.

Methods of Evaluating Techniques. To date the value of industrial operations research, performed as described by nonengineers in the areas of direct concern to the production engineer, has not been established clearly. This raises questions as to methods of evaluation and bases of comparison. It is a fact that much military operations research is taking place and most military staffs in the United States, Canada, and England, now have operations-research groups. Their work is largely classified and is presumably worth while; yet the environment is so different from that of industry that it is dangerous to jump to the conclusion that operations research in industry will be equally successful or necessarily economical.

Study of the cases of industrial operations research available discloses in most early articles considerable ignorance of industry and production engineering on the part of the authors and few examples of other than good engineering practice. More recently, evidence of an approach and methodology apparently very worth while has appeared and we can profit thereby. Yet others seem to be retracing the ground covered by the production engineer some 15 to 20 years ago. The important fact is that in no case is there available a proper evaluation of the over-all economic problem and, as mentioned earlier, this may be impossible.

Often it is not recognized that any process or operation which is allowed to progress for some time without review inevitably is affected by creeping obsolescence and change. Almost any conscientious study will result in material improvement. The standard of comparison, however, is the original state prior to the study and for our purpose this is inadequate.

From any evidence to date or data yet publicly available it cannot be concluded that in any case operations research has returned more per dollar spent than an equal or lesser expenditure by competent production engineers. This does not infer that it is not possible to demonstrate the value but merely that it has not been done in a satisfactory fashion in the area of production engineering. Some firms are now experimenting and it is to be hoped that sufficient data for a judgment ultimately will be available.

Where Does Operations Research Begin? The statement has been made repeatedly that the place for operations research is at a high level on the organization chart. At the other extreme the statement is made that any engineer can do this research as part of his function. Both have a familiar ring and any firm interested would do well to study the history of statistical quality control which furnishes many parallels including these.

Experience would indicate a number of considerations: (1) No one answer suits all situations. (2) Adequate analysis and thoughtful research do not take place as a part-time job subordinated to daily pressures, and hence a unit with this sole function is necessary. (3) Any values to be derived will come solely through adoption of new methods across channels. This difficult problem of selling the solution or the desire for one demands special competence and organizational ability and is perhaps the most important single factor. Finally, the engineer and the scientist both have a place in the program.

Research on a scope sufficient to benefit the production engineer will demand much closer contact and familiarity with the present state of the art than is evidenced by performance of the type of operations-research groups that are made up of pure scientists operating from on high. It also will demand methodology and techniques not possessed by the average engineer. A middle path seems quite essential, with a real interchange of ideas, skills, and techniques that does not come about overnight. It does not appear likely that a firm will be able to buy a package of operations research for work in the area of production engineering but must to a considerable degree develop an integral function.

The methods and objectives of operations research differ markedly from the traditional ones of the production engineer. Many problems, such as materials handling, line balance, and machine utilization, demand better methods of solution than are available. Many of the economic policies, constants, or assumptions which restrict the engineer need further study. These all involve careful analysis by different organizational divisions of a firm, the co-ordination of data derived from the process of analysis, interpretation, and experimentation, and the complete co-operation of all those involved in the work.

Precision Control of

Injection-Molding Pressure

More dependable weigh feeders, uniform molding cycles, and automatic compensation will improve quality of plastic products

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Several means of pressure control have been employed by injection molders. The temperature, pressure, and time controls of molding machines provide relatively wide latitude for this purpose. Balanced gate resistance, flow control within the cavities, mold temperature controllers, restricted gates, ball-check nozzles, and weighed-starved feeding of the molding granules have been employed individually and in systematic combinations to control the plastic pressure. These principles and mechanical devices have been highly successful in improving the quality of injection-molded articles and in decreasing the cost of the molding operations.

It has become well-established that the most effective and precise means of controlling pressure in the mold is to place exactly the correct weight of plastic there as quickly as possible.[1] Weighed-starved feeding of conventional injection-molding machines has been effective in placing the correct weight of granules in the mold. Preplasticizing molding machines has been highly effective in filling the mold quickly. These technical developments have accomplished much progress in broadening the range of safe and economical application of thermoplastics as engineering materials.

Weighed-starved feeding has been found to have some inherent problems which interfere with attaining sufficient precision of pressure control in the mold to make this technique universally applicable for the most exacting molding requirements. Two problems are critical and some remedies may be applied.

Accuracy of the Weighing Device

The principle of weighed-starved feeding is to place the correct amount of plastic granules in front of the injection plunger and push them forward into the heating cylinder until the injection piston can move forward no farther, because it is in contact with the front hydraulic-cylinder head. With this means of operation it is possible to hold the plastic in the mold until the gate has solidified sufficiently to prevent discharge of plastic from the mold. If a cushion of plastic granules remains ahead of the injection plunger after the mold is full, the hydraulic pressure in the oil cylinder is capable of forcing more plastic to creep into the mold during the next few seconds, and this causes packing which results in high residual stress in the molded piece.

Lack of Precision in Weighing. The operation of weighing the charge of molding granules is subject to some lack of precision. No weighing device can measure the exact weight at each cycle of weighing. The weight may be expected to be heavier or lighter than the correct amount. The inaccuracy is usually cumulative, and sooner or later the molding operation departs too far from equilibrium. The heating cylinder will gradually build up a cushion of granules which stops the plunger before it completes its full stroke if the weight of the charge is slightly heavy. Conversely, the heating cylinder will be gradually starved until short unfilled parts result if the weight is slightly too light. This inaccuracy is in the range of plus or minus 0.5 per cent and it is not excessive in itself for many molding applications. Press operators can make periodic compensating adjustments to hold the finished parts within good limits in so far as dimensional accuracy, residual stress, and heat resistance are concerned. Some applications of molded parts require closer control, and automatic molding machines surely need better control than this.

It has been difficult for press operators to learn to compensate for the inherent inaccuracy of the weighers, which is usually small, because of some shortcomings in mechanical dependability of the weighing machines. Improved dependability is the aim of the manufacturers of weighing machines for injection-molding applications, and considerable progress has been made.

Self-Compensating Weighers. Self-compensating weighers have been proposed, and they can be effective in overcoming the inherent inaccuracies. If compensation is controlled by the position of the injection plunger at the end of the injection stroke, the compensation for

[1] "The Technology of Injection Molding, IV—Heavy Sections," by G. B. Thayer, presented before the SPE, January 17, 1952, now a bulletin of Plastics Technical Service, The Dow Chemical Company, Midland, Mich.

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inaccurate weighing will be so coarse it will not add to the precision which is already available. The only way in which a compensating weigh feeder can be controlled by plunger position is to operate with a cushion of granules in front of the plunger which is maintained at a constant height by the compensating feature of the weigher. This would be reasonably satisfactory for some applications, but it is not very precise.

The compensation of the weight of the charge should be based on the pressure which exists in the fluid plastic at the instant the hydraulic piston reaches the front cylinder head. This bases the control of the molding system upon plastic pressure which is the factor to be controlled. Furthermore, it can provide compensation for the second inherent problem which is involved in precision control of pressure through a conventional injection-molding heating cylinder.

Conventional Heating-Cylinder System

Fig. 1 is a schematic diagram of a conventional injection-molding heating cylinder which may be defined as one which receives a charge of cold granules at one end and delivers a charge of melted plastic from the other end into the runner system of the mold. Immediately in front of the injection plunger upon completing its forward stroke, there is a region of packed granules which extends some indefinite distance forward into the heating cylinder. These granules are increasingly softer and more nearly melted toward the nozzle end of the heating cylinder as indicated by the diagram.

Operation of System. When weighed-starved feeding is employed, the injection plunger must stop its forward motion at a fixed position upon completion of each stroke. It is restrained by the front hydraulic-cylinder head. The plunger is relatively rigid, but the plastic between the end of the plunger and the gate of the mold is rather highly compressible. Fig. 1 shows the compressible portion of the plunger system which exists inside the heating cylinder. Fig. 2 shows the complete plunger system and divides it into rigid and compressible portions. The compressibility of the plastic portion of the plunger system can introduce much more inaccuracy in a weighed-starved feeding system than does the weigh-feeding machine.

The front end of the plunger transmits pressure through the packed granules and through the fluid plastic into the heating cylinder and runner system into the mold. The fluid plastic is compressed to some extent, perhaps 4 to 7 per cent, after the plunger reaches its forward position with the mold closed. The packed granules also are compressed.

A plug of packed granules acts as an extension of the plunger and transmits pressure to the fluid plastic. The rigidity of this plug of granules can vary because of several factors. The temperature of the granules helps to determine their ability to push the fluid charge forward. External lubrication conditions can cause variation in the effective length of the plunger. The size and shape of the granules have a similar effect.

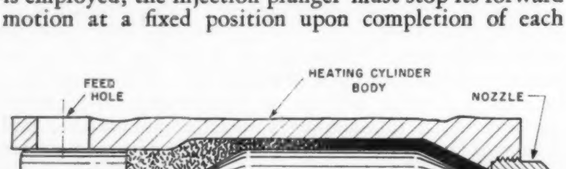


Fig. 1 Schematic diagram of conventional injection-molding heating cylinder

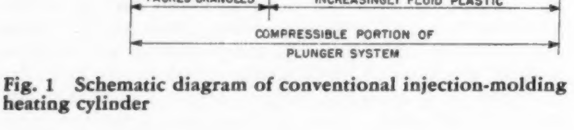


Fig. 2 Complete plunger system showing rigid and compressible portions

Resistance to Flow. The resistance to flow through a heating cylinder depends principally upon the mass-average temperature of the fluid plastic and upon the sliding friction of the cold plug of granules against the heater wall. Slight variations in the time cycle of the molding machine can cause considerable variation in the average temperature of the fluid plastic, and in turn this causes considerable variation in the fluidity or ease of pushing the plastic through the heating cylinder. The variation in the resistance to flow of the fluid plastic causes a change in the compressive load on the packed granules. This changes the height of the column of granules and, in effect, changes the position of the end of the injection plunger and its effective length. Also, the friction of the plug of granules against the heater wall has a similar effect.

Thus a change in the average temperature of the fluid plastic causes a variation in the amount of plastic which is introduced into the mold. A variation in the temperature or lubrication condition of the granules causes a difference in the compressibility of the column of granules and changes the effective length of the plunger. Both factors may be operating simultaneously or separately. The effect may be cumulative or not. Hence, it can be seen that these conditions of compressibility in the plunger system can amount to much greater variation in the amount of plastic introduced into the mold than the relatively small inaccuracies of an uncompensated weigh-feeding device.

Compensating for Compressibility. Difference in the effective length of the plunger as a result of variation in compression of the fluid plastic probably is a considerably lesser factor than the variation of the plug of cold granules. The compression of the fluid plastic is not negligible, however. These variations in compressibility of the plunger system can be compensated if the control is based upon the pressure of the fluid plastic in the nozzle of the molding machine. It has not been simple to install a pressure-control device at this point because of space limitations. A simple pressure-limit

switch is needed to perform the control signaling at this point.

It is possible for the molding-machine operator to compensate to some extent for the compressibility of the plunger system by means of plastic-temperature and time-cycle adjustments. If the weight of the charge is correct, changes should not be made in the weighing device but should be accomplished by means of temperature and time. This type of compensation can be expected to be required during relief periods when a different operator is at the machine. No two operators work exactly alike as far as time cycles are concerned. Relief operators may find the machine goes out of equilibrium, and may make adjustments to the weighing device. When the regular operator returns, he finds the machine is out of equilibrium for him. This condition also is likely to occur at the time of shift changing. The weighed-starved feeding system is so sensitive, a few seconds' time delay in a cycle can cause a change of equilibrium conditions. Ten seconds are more than enough to throw the weigh-feeding system out of balance. If the operator does not realize this, he finds himself adjusting the weighing machine in a futile attempt to obtain equilibrium again. This has brought about considerable unwarranted criticism of mechanical dependability of the weighing units. He must learn to readjust his condition by timing and temperature in this case rather than weight adjustments.

Preplasticizing Machines

Recent experience with preplasticizing machines which employ a heating chamber of some kind to introduce fluid plastic into a transfer or injection chamber has indicated there is considerable advantage in this technique. High injection speed can be obtained and molds can be filled in one second or less. The higher speed of injection results in much better distribution of pressure inside the mold, and there is much less difference in pressure between the region at the gate and the remotest extremity of the mold. The conventional heating cylinder cannot fill the mold as rapidly without having an excessively large hydraulic power plant. Furthermore, it is possible to overcome the disadvantage of compressibility of the plunger system which is brought about by the packed granules.

Fig. 3 is a schematic diagram of a preplasticizing system which is a composite of several systems now in use. There is no preplasticizing system exactly like this one which has embodied advantages from several and has avoided disadvantages of several others.

In this machine the fluid plastic is introduced in front of the injection plunger and pushes it back as the plastic enters. This minimizes the introduction of air into the molten plastic. Some systems employ a heating cylinder which introduces the fluid plastic into an open injection chamber at a time when the injection plunger is withdrawn. There is considerable danger of introducing air into the plastic in such systems, although it is possible to operate them with reasonable satisfaction. If air is introduced into the fluid plastic, it is likely to cause detonation inside the injection cylinder. The air is compressed rapidly and becomes hot enough to burn the plastic until the oxygen present is consumed. Usually this burning occurs so rapidly there is a sharp detonation. The plastic then comes into the mold with black streaks.

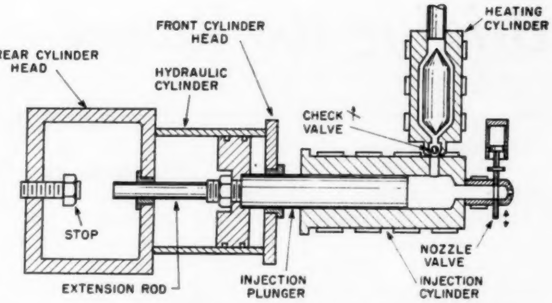


Fig. 3 Schematic diagram of preplasticizing system—a composite of several systems now in use

At the time of introduction of the plastic into the injection cylinder, the nozzle valve is in the closed position so plastic cannot leak out of the nozzle tip. The fluid plastic forces the hydraulic piston back until the extension rod hits the preadjusted stop as shown in Fig. 3. If a constant-pressure condition is employed on the plunger of the heating cylinder and it in turn is able to transmit a constant pressure on the fluid plastic, it is possible to measure the weight of the charge rather accurately even though the measurement is actually by volume of fluid plastic under constant pressure and temperature conditions. It appears from present experience this is a feasible and simple method of introducing greater precision into the injection-molding process.

When the injection plunger moves forward, it must move until the hydraulic piston comes in contact with the front cylinder head, and therefore can move no farther. During this time the nozzle valve must be open and the check valve on the heating cylinder is forced into a closed position to prevent backflow of the fluid plastic into the heating cylinder. The plunger may be held in the forward position until the gate has solidified sufficiently to prevent plastic discharge from the mold, or the plunger may be withdrawn immediately while the nozzle valve is closed simultaneously.

Some molding systems employ a receiving chamber which receives the melted plastic from the heating cylinder and then dumps the charge into the injection cylinder. This allows the receiving chamber to hold fluid plastic under more nearly constant-pressure conditions and to deliver it to the injection chamber under better pressure-control conditions.

The systems which are discussed in this paper are suggested as a means of increasing precision in the injection-molding process. Some of the features which are shown are subject to patents or patents pending.

Major Problems First

Greater precision in the control of injection-molding pressure can be obtained most readily by recognizing the major problems and dealing with them first. Improved dependability of weigh feeders will provide a considerable improvement before it is necessary to compensate for the inherent weighing inaccuracy. Careful attention to uniform molding cycles can provide better precision without automatic compensation. Automatic compensation needs dependable equipment and uniform molding cycles before it can be effective.

Briefing the Record

Abstracts and Comments Based on Current Periodicals and Events

J. J. Jaklitsch, Jr., *Associate Editor*

Fig. 1 Workmen constructing the first rubber railroad crossing in the world at Akron, Ohio. It is built of 3-in-thick rubber slabs, specially compounded and including a sandwich layer of heavy-gage metal, built by the Goodyear Tire & Rubber Company.

Rubber Railroad Crossing

The first rubber railroad crossing in the world has been installed on the main track of the Erie Railroad at Wilbeth Road in Akron, Ohio. The material for the crossing roadway was supplied by the Goodyear Tire & Rubber Company of Akron.

As automobiles and trucks rolled smoothly over the tracks, engineers predicted that the rubber installation would eliminate one of the major irritations of motorists and would prove a boom to railroads through greatly reduced maintenance expense.

The rubber material, it was indicated, provides the most satisfactory, smoothest, and longest-lasting railroad crossing yet devised.

Other possibilities for similar installations include the many places where streets and highways cross railroad tracks throughout the country; railroad-station areas where passengers and baggage trucks must cross one or more sets of tracks; and factory receiving and shipping areas where similar conditions are encountered.

The rubber vehicular roadway between the tracks is built with slabs of rubber measuring 36 in. wide × 59 in. long. They are a little more than 3 in. thick, including a sheet of heavy-gage steel sandwiched within each slab. The rubber roadway rests on heavy treated-wood plank-

Fig. 2 Rubber slabs used between tracks and at approaches on both sides of rails are fastened. Slabs rest on heavy planking laid over crossties and are fastened down by 12-in. lag screws, held securely in place by metal and rubber grommets.

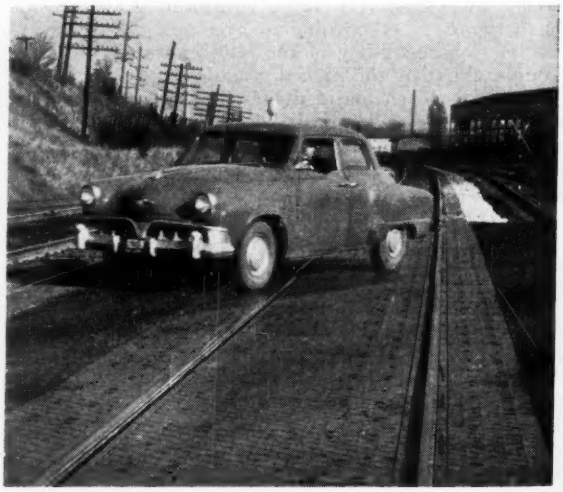


Fig. 3 Car rolls smoothly over rubber railroad crossing of Erie Railroad at Wilbeth Road in Akron, Ohio. Two major advantages are seen in the new-type crossing, a smoother ride for motorists, and less maintenance expense for railroads.

ing, called risers, laid on top of each regular railroad tie and each slab is fastened down by lag screws 12 in. long, installed through metal and rubber grommets to hold the slabs securely in place.

The rubber slabs are designed with tapered flanges where they meet the rails. When sprung into place, the rubber flanges form a watertight wedge to the rail, thus preventing seepage which causes deterioration of ties and fouls ballast in the crossing. Under normal conditions the rubber installation should last indefinitely, according to engineers.

Smaller rubber slabs were used outside of the rails, extending to the tie ends of the tracks and these, too, form a watertight union with the rails.

Special wear and skid-resistant rubber compounds were used. Surface of the rubber roadway is built with a diamond design molded into the rubber slabs.

The rubber crossing is expected to be a proving ground for various types of roadway-crossing materials.

Radar Mortar Locator

A VITAL new use of radar in ground combat, to detect and track down the source of enemy mortar fire, was disclosed recently by the Department of the Army.

The Army also revealed that American ground forces in several theatres already are equipped with electronic mortar-locator systems.

Known as counter-mortar radar AN/MPQ-10, the device was jointly developed and designed by the U. S. Army Signal Corps and the Sperry Gyroscope Company. Early production systems were flown direct from the factory to Korean battlefields in December, 1952.

With the aid of this new electronic locator, now far advanced from the experimental stage, front-line forces can detect and "lock on" the path of enemy mortar shells, automatically track their trajectory, and reveal the enemy position.

Fig. 4 New Army versatile mobile radar eye, triple threat on defense and offense, acts as sentry, warns of enemy movements, and pinpoints enemy mortar locations for destruction. This unit is easily transported and can be remotely controlled.

These co-ordinates then are relayed to an artillery Fire Direction Center, which responds with precisely aimed fire to eliminate enemy mortars within moments after they open fire. Hundreds of soldiers, now returned safely from Korea, literally owe their lives to the extreme accuracy and speed of the new counter-mortar system, the Army said.

The equipment is compact and mobile and can be towed by a light Army truck for quick movement in battle. The system consists of a large automatic radar tracker with dish-shaped antenna, a gasoline motor generator of Signal Corps' lightweight design, a portable tracker mount resembling a 40-mm gun carriage for rapid movement to new positions, and a separate remote-control console with radarscopes and all controls used during operation of the radar set.

The modified gun carriage mounts six major components of the radar system including elevation and range computers. Extension cables permit operators to work the set from positions remote from the large automatic tracker, which tilts up or down and rotates in all directions for continuous search.

One radar officer commands the skilled operations team who translate radar plot to precise co-ordinates for artillery counterfire. Their portable control unit is about the size of a large-screen home television set and can be concealed readily in protected dugouts, trenches, or foxholes.

Color Television

DEVELOPMENT of color television has been slow and costly. In fact, accurate color reproduction in any medium is still expensive and reproducing color electronically adds a new dimension of difficulty, according to the *Industrial Bulletin* of Arthur D. Little, Inc., for November, 1954.

Most color-reproduction methods depend on the use of three or more primary color components that, mixed and presented to the eye, produce the required illusion. For instance, a magazine illustration consists of red, blue, yellow, and black components superimposed. Similarly, a Kodachrome transparency consists of three colored layers of emulsion, separated by filter layers and mounted on a transparent film base.

Since each color component alone can carry as much detail as a black-and-white picture, it would seem that a color-transmission system would have to handle at least three times as much information, and would therefore cost much more. In color TV, moreover, another important factor arises; the amount of information to be transmitted controls the width of the broadcast band occupied by a station and hence the possible number of stations, since available broadcast frequencies are limited by Government regulation. A black-and-white television channel already occupies a band at least 600 times as wide as a radio channel; broadcasting in three fully detailed colors would take nearly three times as much space. Thus two out of three black-and-white channels would have to be scrapped to make room for color—obvious nonsense to any self-respecting network, the *Bulletin* states.

The first answer proposed was to sacrifice detail and hope that the added realism of color would make up for it. In the "field-sequential method," the three colored components of each frame (one scanning the image) were

projected in sequence. To keep within channel limits, the number of lines per frame (the detail) had to be reduced from 525 to 405, and the number of complete frames per second, from 30 to 24. These standards, therefore, were incompatible with those for present black-and-white receivers; the consumer would need a different set to receive color broadcasts. The method of producing color was to use a disk with three colored filters revolving at high speed in front of the picture tube. Since the diameter of the disk was more than twice the diameter of the picture tube, it severely limited the practical size of the picture.

New Standards

Such difficulties have now been overcome through ingenious new conceptions of color reproduction, developed through continued research. The National Television System Committee has produced an entirely new set of standards for color television, and the Federal Communications Commission has withdrawn its previous exclusive sanction of the field-sequential method. Equipment manufacture now follows the new "compatible" system, wherein a color receiver will handle regular black-and-white broadcasts as well as color, and a standard black-and-white receiver will handle color broadcasts—in black and white.

The new color standards require no change in channel allocations, a result that stems from psychological as well as electronic skill. If all the detail of a picture is available in black and white and the color information is available in broad outline, the eye of the viewer is well satisfied.

The new TV system resolves a picture first into a brightness or "luminance" component that provides all the detail and corresponds exactly to the present black-and-white TV picture signal, and two "chrominance" signals that represent the difference between the luminance and the red and blue color components. The latter have much less detail than the luminance signal. They have, in fact, been tucked into a corner of the channel; the black-and-white receiver does not notice them, but the color receiver can distinguish them with reference to a short burst of energy at a special frequency that occurs at the start of each scanning line.

Picture Tubes

The next problem was to make a color receiver that would translate this rather complicated code into three color components and into a colored picture. The earliest types used three cathode-ray tubes whose images were optically superimposed, but this was clumsy and difficult to adjust. Next came a cathode-ray tube with three electron sources or "guns," each producing a beam of electrons. Between the guns and the face of the tube is a screen with a large number of small holes. If the beams from the three guns are all focused on one hole, they will impinge on the viewing screen at three different places. At each of these places there is a spot of phosphorescent chemical that glows in one of the three primary colors. Each gun, therefore, interprets a third of the broadcast signal, and produces a third of the final color image.

As a further step, a single-gun tube has been invented. Here the colored phosphors are laid in stripes on the face of the tube and a series of parallel wires adjacent to the stripes focuses and deflects the electrons in the single beam onto the correct color stripe, according to the directions of the broadcast signal. Again, the illusion of the full-color image is produced by the eye, which fuses the information contained in the closely spaced stripes that each produces only one color.

Whatever the type of picture tube ultimately adopted, color TV is close to being here in quantity, the *Bulletin* notes. A 95-city network is projected by the end of 1955. The electronics industry, whose annual sales already reach $4 billion, is expected to benefit considerably from the widespread adoption of color.

New Alloy Steel

An alloy steel, with high resistance to impact and abrasion, has been announced by American Steel Foundries, East Chicago, Ind. Known as Wearpact, this steel has been subjected to extensive field testing in taconite, hematite, and copper-mining operations.

The new alloy is unique in the sense that high initial hardness (470–520 Brinell), as shipped, is combined with high resistance to impact. This initial hardness is retained in sections up to 6 in. thick, with only a slight reduction in hardness of thicker sections.

Briefly, Wearpact has a tensile strength exceeding 220,000 psi in normal range of 470–520 Brinell hardness. Yield point exceeds 180,000 psi making Wearpact highly resistant to flow and distortion. These values are retained at operating temperatures ranging from 450 F to —50 F. Charpy impact values are approximately 20 ft-lb.

Wearpact can be welded by conventional arc-welding methods; its hardness is affected only in immediate area of the weld. It is machinable, using heavy-duty equipment, or it can be finished by grinding. It is magnetic, which means that should Wearpact teeth or other parts disengage, they will be picked up by magnetic separation equipment before entering crushers. Differential hardness of castings is obtainable when a need exists for soft center sections—such as required for easy machining or splining of bores.

No difficulties have been encountered in casting the new alloy; it has been cast in the form of large crusher segments down to the smaller-sized dipper teeth. Shrinkage rate is comparable to that of most cast steels and special patterns are not usually required. In many cases, patterns designed for use with austenitic manganese steel can also be used.

Direct comparisons have been made on applications where Wearpact replaced other alloy steels. For example, in the case of a chute liner handling taconite rocks up to 8 in. in diam, Wearpact outlasted the best of the previously used liners some $2^1/_2$ times. On a concave crusher handling taconite boulders, Wearpact liners have shown no measurable flow or distortion after four months of service. Wearpact dipper teeth, in direct comparison to other alloys, show a service-life ratio of as much as 3 to 1, it is reported.

Aircraft Loading Dock

A mechanical device which docks an aircraft by moving it sideways to a covered pier or dock has been developed and constructed by the Whiting Corporation of Harvey, Ill. Called the Whiting Loadair, the device will enable passengers to board planes directly from an

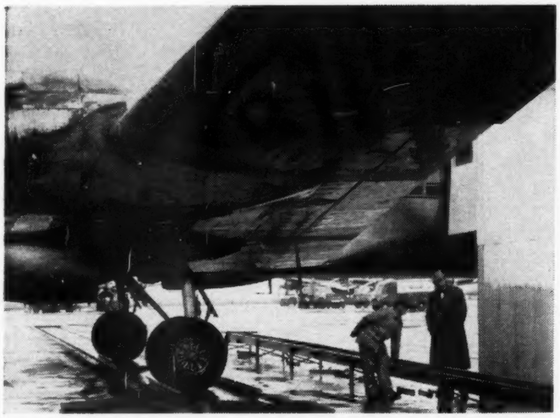


Fig. 5 An American Airlines DC-7 is shown on the Whiting Loadair which is moving it on cars along tracks to a point where the plane's door will be flush with the entrance to the terminal. The landing gear of the plane is shown on the cars while the plane is being moved.

Fig. 6 Passengers can now pass from a terminal to an airplane without going outdoors by means of the Whiting Loadair dock. Baggage will also be handled from plane to baggage-claim area by means of conveyers direct without rehandling.

airport terminal building without being exposed to the weather. In addition, baggage will be handled for the first time from plane to baggage-claim area by means of conveyers direct without rehandling.

The Port of New York Authority, which operates the New York International Airport where the first Loadair system in the United States is installed, furnished the site and co-operated by providing technical advice. The Loadair is located at Gate 4, New York International Airport, adjacent to American Airlines and will be used by American and other airlines in the pilot operation.

In operation, the aircraft taxies into position placing its wheels on dollies and stops its engines. The Loadair winch then moves the dollies on rails so that a 75-ton aircraft is moved sideways about 90 ft in less than a minute until its door is flush with the entrance to the Loadair dock. The operation is controlled by two push buttons (one at the dock and one on the ramp) and there are limit switches which automatically stop the aircraft at the proper point. Conversely, a departing aircraft is moved sideways away from the dock to the point where it starts its engines and taxies off the dollies.

Whiting and Westinghouse Electric Corporation engineers worked for many months to devise a power drive that would handle requirements for a fast, accurate, and economical system.

The result was a four-motor combination. A 20-hp main-drive motor powers the winch that pulls the plane sideways.

Three explosionproof Westinghouse motors are utilized on the baggage conveyer belt produced by the Stephens-Adamson Company, of Aurora, Ill. Now air cargo is electrically transported from the plane directly into a baggage room at the rate of 150 fpm.

The electric panel and controls were especially designed by Westinghouse to start and stop the transporting system. Electric power from a three-phase, 60-cycle, 208-volt line supplies the control panel from a main switch.

Four push-button stations are provided, one at upper platform level, one at main dock level, and one for each of two operations on the ramp. Each station has buttons identified as "in" and "out" and a switch marked "on" and "off." Buttons located in the dock area are for "inching" the plane the last few feet when docking.

The Loadair dock itself is a specially designed building from which the passenger steps directly into the aircraft. This is 94 × 10 ft of steel construction. The outer or plane end has two stories. The upper story is used for boarding the four-engine-type aircraft and for cabin-servicing use. The lower story is used for boarding the smaller twin-engine aircraft. The lower level is also used for baggage reclaim and ticket check-in prior to boarding the aircraft.

The approximate cost of the Loadair facilities, including machinery and dock, is $90,000.

Seamless-Tube Finishing

New finishing facilities for producing oil-country tubular products in the high strengths necessary for deep drilling are now in operation at Jones & Laughlin Steel Corporation's Aliquippa Works. Called the "Seamless Tube Specialties Department," this is the first step in expansion of facilities for finishing high-strength and special seamless-tube products used in the oil industry.

Speedier Improved Facilities

In the new department, equipment of J&L design makes possible finishing of seamless oil-country casing and tubing by quench and temper heat-treatment, imparting to these products characteristics that formerly were attained through adjustments in the chemical composition of the steel.

By speeding up and improving the finishing facilities, the new installation will tend to increase the total output of J&L high-strength seamless pipe.

The new process also will result in savings of many tons annually of strategic alloying materials—manganese, molybdenum, and chromium—formerly used in steels for high-strength seamless pipe.

The heat-treating equipment consists of two hearth-type mechanically operated gas-fired furnaces with a water-spray quenching unit between them. One furnace is a high-temperature furnace. The other is a tempering furnace.

Fig. 7 Interior of high-temperature 1650-F furnace. The pipe moves through slowly from left to right on the conveyerized furnace bottom passing out the exit door at rear.

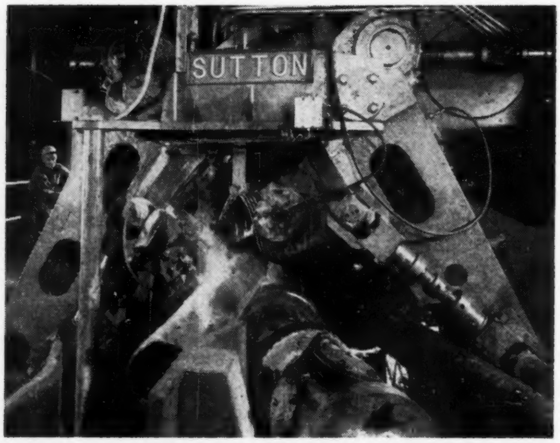


Fig. 9 Exit end of large rotary straightening machine. From here the pipe progresses to the cutting and threading machines. Equipment also includes a gag-press straightener.

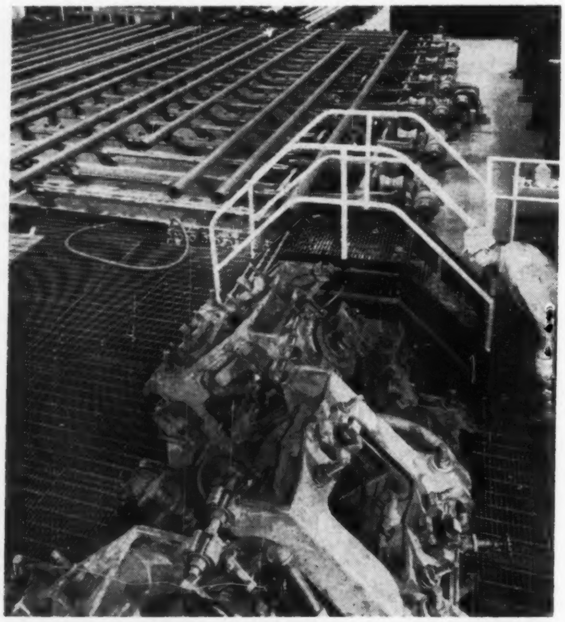


Fig. 8 Three-stand reducing mill, *foreground*, at exit end of tempering furnace, sizes pipe to exact diameter. Cooling bed, *top*, moves and assembles pipe for further processing.

Fig. 10 Here threaded pipe is shown being moved out of the threading machine. Prior to the threading operation, a cutoff machine lops off the rough ends of pipe.

Processing of the various products may involve normalizing, or normalizing and tempering, of alloy steels, or the quenching and tempering of plain carbon steels.

The seamless pipe, produced in the existing mills, will come to the new department on new 15-ton side-operated lift trucks.

When normalizing, the pipe passes through the high-temperature furnace. By controlled heating and cooling through the transformation range of the steel, the grain structure is refined and made uniform.

When quenching, the pipe is first heated in the high-temperature furnace above the upper transformation temperature. Then it passes through the quenching unit, where it is water-sprayed with high-pressure injector-type nozzles. Quenching hardens the steel.

Then the pipe passes through the tempering furnace. By gentle reheating, tempering restores to the quench-hardened steel the desired degree of ductility and toughness.

Other equipment in the new building consists of a three-stand sizing mill for sizing the pipe to exact diameter; a rotary straightener; a gag-press straightener; cutoff and threading equipment for final finishing operations; pipe storage racks, fuel-oil storage tanks, and an office.

A 6900-volt power line and substation building provide 60-cycle power to the new operations.

Deep-Well Drilling

Every deep well—that is, wells over 10,000 ft—make terrific demands on drill pipe, casing, and tubing. Because of the trend to deeper wells, and because of extraordinary requirements in offshore drilling, the drilling industry now requires grades for oil-country tubular goods with minimum yield strengths as high as 110,000 psi.

The actual drilling of the well is performed by a bit threaded on the lower section of the drill-pipe column. Mud of controlled composition is pumped through a rubber hose attached to the top of the string of drill pipe by a swivel arrangement. This mud is pumped down through the drill pipe, out the bottom, and returns to the surface on the outside of the drill pipe. Purposes of the mud:

1 It removes the cuttings from the bottom of the hole which are allowed to settle out on the surface before the mud is recirculated.

2 It lubricates the drill pipe, reducing friction and abrasion due to contact with the rock formations through which the pipe rotates.

3 It serves as a seal to prevent blowing-out, due to oil or gas pressures in the well.

4 It helps prevent seepage or cave-ins.

Casing is provided in the well, outside the drill pipe, to prevent caving-in of the hole, and to seal off contamination from surface water or salt water.

After the well is completed, tubing is installed to bring the oil to the surface. If there is not enough natural pressure, the well is pumped by means of a pumping mechanism placed in the tubing.

Heaviest demands are made on the drill pipe. This, at record depths, is a rotating column of joined sections of steel pipe, almost four miles long, transferring energy from the surface to the drilling bit at the bottom of the well.

Wells are seldom straight, and it is not uncommon for the hole to corkscrew or to be several hundred feet off the perpendicular, making a severe test on the mechanical properties of the drill pipe.

The casing must be strong enough to support its own weight, and to withstand internal and external pressures.

In wells of record depth, the casing at the top of the well might be supporting 250 tons or more of casing below it.

Internal pressure comes when the oil or gas areas are reached. This may exceed 10,000 psi. External pressure is due primarily to the weight of the mud column. A 10,000-ft mud column exerts a pressure of 5000 psi or higher, depending on the density of the mud.

Tubing requirements are similar to those for casing. Where natural pressure is insufficient, a pumping mechanism is installed at the lower part of the tubing. Wear, vibration, and corrosion limit the life of the tubing.

Fig. 11 Ready for shipment, this $9^5/_8$-in. seamless tubing has been heat-treated, sized, straightened, and threaded. The tubing has a wall thickness of $^3/_8$ in. and ranges in length from 18 to 45 ft.

Titanium-Industry Review

THE producers and processors of metallic titanium scored encouraging gains in 1954, according to T. W. Lippert, manager of sales and technical service, Titanium Metals Corporation of America, New York, N. Y. Production of basic metal more than doubled the 1953 figure. More important were the impressive improvements in quality, the significant reductions in metal-processing losses, and the evolution of a firm and documented physical-metallurgy pattern which assures in 1955 and 1956 many new and advanced alloys of exceedingly high strength and for high-temperature service.

Each of the two commercial producers of raw titanium sponge, TMCA and E. I. du Pont de Nemours, achieved 10-tons per day capacity production by late summer. Compared with a 1953 output of 2250 net tons, total 1954 sponge production is estimated by Government agencies at 5250 tons, of which TMCA and du Pont contributed about 2500 tons each and the Bureau of Mines added 150 tons; other pilot units made up the remainder. Imports from Japan followed a rapidly rising curve by midsummer, the year's total being 250 tons.

The year was marked by substantial price markdowns. In February TMCA led off with reductions in sheet, strip, and plate which in certain grades and sizes amounted to 12 per cent, thereby establishing new market prices for those products. Lower market prices for bars and billets were set several weeks later when Rem-Cru Titanium, Inc., cut its prices for those products by as much as 14 per cent. Sponge prices were also reduced during the year, initiated by du Pont. The price of sponge was reduced from $5 to $4.72 per lb on April 1, 1954, and further reduced to $4.50 on Dec. 1, 1954.

While all these reductions were decidedly encouraging for such an infant industry, many trade observers look for even more significant declines in 1955, if the industry can continue its fast production and development pace and fully exploit current pilot operations leading toward full recycling of scrap metal.

The drastic tightening and retightening of customer specifications throughout 1954 was reflected in a succession of production upheavals. However, industry sources do not anticipate much further burdensome and costly narrowing of specifications in 1955, for titanium mill products are today moving under customer limitations of a rigidity not to be duplicated in other structural metals having decades of production history.

For the past five years titanium sponge production has at least doubled each year, and some sources indicate a possible doubling again in 1955, or an output of 10,500 tons. More conservative estimates list a likelihood of about 8800 tons in 1955, with the possibility of 15,200 tons in 1956, and 22,500 tons in 1957. The only new facility certain to contribute significant quantities of metal in 1955 will be Cramet, Inc., a Crane Company subsidiary, which is constructing a 6000-ton per year plant at Chattanooga, Tenn., under a contractual arrangement with the General Services Administration. The Dow Chemical Company plant, Midland, Mich.,

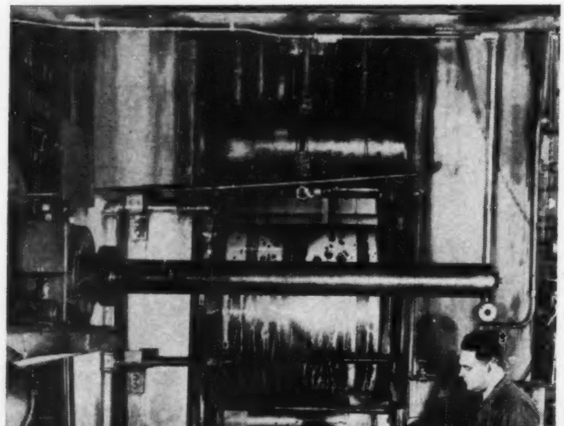


Fig. 12 Cold-rolling 36-in. titanium strip sheet at the Titanium Metals Corporation of America

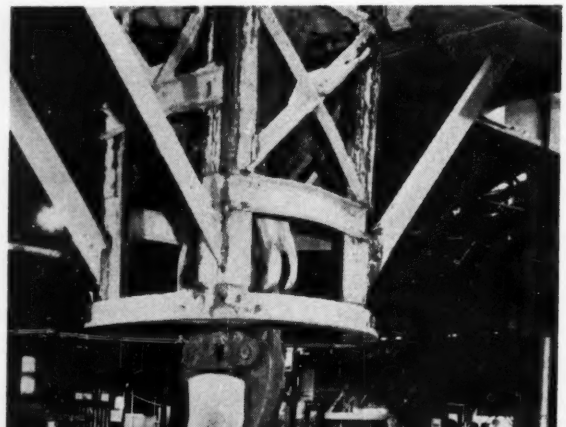


Fig. 13 A 4000-lb titanium slab being removed from soaking pit for continuous rolling into 48-in. sheet

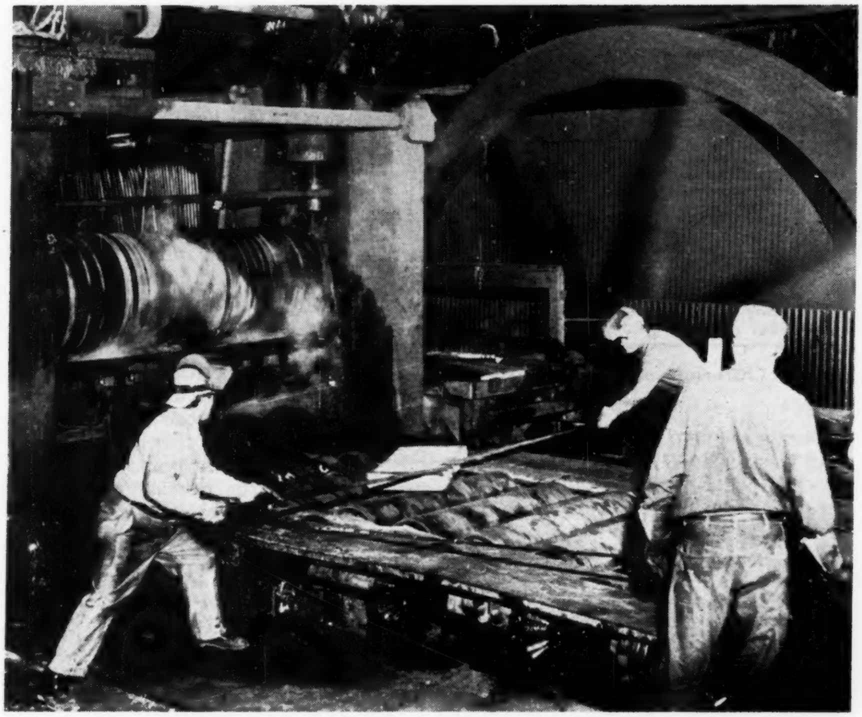


Fig. 14 Titanium-alloy armor plate is shown being rolled

under GSA contract for 1800 tons annually, probably will come in with pilot quantities during 1955, but likely won't approach capacity operation until late 1956.

One of the most significant new entries into the production field in 1954 was the Electro Metallurgical Company, a division of Union Carbide & Carbon Corporation, which late in the year completed negotiations with the government for a 7500-ton per year plant at Ashtabula, Ohio, and has announced late 1957 as its target for full production. Horizons Titanium Corporation is building a small electrolytic pilot unit at Stamford, Conn., under a government research contract; Kennecott Copper Corporation has announced the likelihood of a 3-ton per day semicommercial plant; and there are rumors that Britain's Imperial Chemical Industries (which is constructing a 1500-ton per year plant in England) intends to construct a facility in the United States.

GSA has under active consideration a second contract with TMCA for an additional 5400 tons per year at Henderson, Nev., and with du Pont an additional 7200 tons per year near Waverly, Tenn., and has under preliminary negotiation contracts totaling 20,000 tons per year with other firms.

On the technological front, no new or particularly significant technique for producing the basic sponge metal has made its appearance. However, both the Electro Metallurgical Company and Imperial Chemical Industries have attracted considerable attention by reverting to a modification of the original method of producing metallic titanium, using sodium to reduce the tetrachloride, as against the magnesium (Kroll) reduction of the tetrachloride as practiced by TMCA, du Pont, and Cramet. The only fully integrated facility operating or in the planning stage is TMCA, which carries ore through the entire productive sequence to finished mill products, and is unique in that it recycles the by-products of reduction, i.e., chlorine and magnesium. In the melting of titanium sponge, the double-melting and vacuum-melting techniques, announced early in the year by TMCA, are apparently becoming standard practice throughout the industry.

Steel Production

STEEL output in 1954 was among the ten highest in the history of the United States. At the same time, 1954 will be known as a year in which the steel industry made much technical progress, while it continued to modernize and expand its facilities.

Steel production rose rapidly during the autumn of 1954. The weekly index of approximately 110 (1947–1949 = 100) showed that output at mid-autumn was exceeding the average in the three-year base period by at least 10 per cent.

A continuation of the mid-autumn rate of output would mean a 1954 total of about 87 million net tons of ingots and steel for castings, a level exceeded only once in a wholly peacetime year. That year was 1948 when steel production was 88.6 million tons. Six other years with larger tonnages ranging from 88.8 million tons in 1943 to 111.6 million tons in 1953, were wholly or partly under the influence of wartime or defense demands. The 87-million-ton figure for 1954 is not a forecast but a projection based on an assumption of production at about 1,788,000 tons a week, 75 per cent of capacity, which would put the index at 111.3. Early in November this level was exceeded.

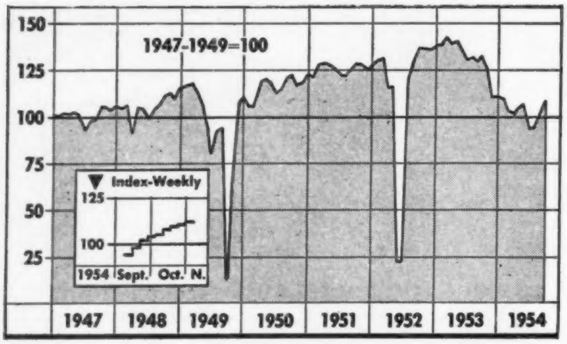


Fig. 15 Chart showing index of yearly steel-production rises

During the first ten months of 1954 the production of steel was nearly 72 million tons, compared with a little less than 95 million tons during the corresponding 1953 period, and exceeded any full year's production prior to 1941.

Building and Cans Gain

Construction and canmaking proved to be the mainstays of the steel industry, at least through most of 1954. In the first eight months they were the industries showing larger receipts of steel than in the similar 1953 period. The oil and gas industry, agricultural equipment, and contractors' products (plumbing, hardware, etc.) took only slightly less than in 1953.

In September, while steel for construction lagged a little behind its earlier strong trend, shipments to most other industries were showing substantial gains over the low levels of the summer. Demand appeared to be gaining momentum, as the increase in total shipments in September over August was 323,000 tons compared with a gain of 191,000 tons from July to August. Total shipments of steel products by the producers in the first nine months of 1954 were 47,450,000 tons, compared with 61,848,000 in the corresponding part of 1953.

In the latter part of 1954 the continued awarding of large construction contracts, especially for housing, offices, public buildings, and highways, indicated further large demand for steel in this field, including construction and earth-moving equipment.

Technology Improved

Steel companies made much progress in science and technology during 1954. The developments included new and improved operations in the preparation and usage of raw materials, in furnace practice, and in the manufacture of steel products.

Raw-materials activities during 1954 included the further development of taconite ores in the Lake Superior region, and the launching of huge building programs for plants to beneficiate the ores. The first commercial plant for the preparation of jasper—another low-grade iron ore—began production in a small way in 1954, and large expansion is planned.

Shipments of iron ore from the Quebec-Labrador region of Canada began during the year.

Another step forward was taken in the use of rare earth elements as addition agents in the manufacture of stainless steels. Metallurgists of a steel company which has worked with these elements asserted that their use improves the hot-workability of some stainless steels.

Two new developments in steelmaking furnace technique in this country occurred during 1954. The vacuum melting of high-temperature alloys and construction alloy steels became a commercial operation.

Also, during the year, an American steel company obtained a license on a process involving the use of oxygen in the operation of a Bessemer-type converter. Ability to make small tonnages of steel very rapidly is an advantage claimed for the new process.

Continuous casting, in which molten steel is cast into billet form in a single operation, was used to produce commercial quantities of billets for seamless tubing and other end products.

Several steel companies began the production of hot extruded, irregular shapes in both stainless steels and tool steels during the past year.

Another development during the year involved an interesting and relatively new use of steel. Steel is now the primary material used in the manufacture of cartridge cases for the United States Army. Steel companies co-operated in the development of steel cases during World War II. Military men say that conversion to the use of steel for this purpose is almost complete as of 1954.

Two steel companies took steps to explore the field of atomic energy. In the first full year that nuclear science has been open to private industry, one steel company signed a contract with the Atomic Energy Commission to study the equipment aspects of nuclear-power development. Another company set up a group to study applications of atomic energy, including power, in steel-plant operations.

Electronic Measuring Instruments

Three new electronic instruments which will have wide applications in all fields of mechanical design, research, and materials testing, were previewed recently by the Instrument Division of Allen B. Du Mont Laboratories, Inc., at Clifton, N. J. The instruments, which include the Du Mont Type 324 cathode-ray oscillograph, the Type 325 strain-gage control, and the Type 332 differential transformer control, are expected to play important roles in the automotive, aviation, petroleum, and structural-engineering industries, in guided-missile and atomic-energy research, as well as in multiple phases of electronics.

The Type 324 cathode-ray oscillograph is the first commercial oscillograph with complete precision calibration and an extremely high-gain d-c amplifier, capable of measurements in microvolts with excellent stability and exceptionally low noise and hum. The unusually high gain permits use of the instrument without preamplifiers for measuring signals from virtually any mechanical transducer. Amplitude ranges extend 16 calibrated steps from 4 millivolts full scale to 400 volts full scale with balanced input available on seven most sensitive ranges where this would be most needed. The Y-axis frequency response of the Type 324 extends from d-c up to 300 kc, depending on the sensitivity range. The X-amplifier frequency response extends from d-c to 300 kc, with a sensitivity of 3 volts p-p for full-scale deflection.

The Type 335 strain-gage control is designed for use with any commercially available strain gage. It may

be used directly with the Type 324 or, using suitable preamplifiers, with any cathode-ray oscillograph. It may also be used with indicating devices such as recording galvanometers and meters. The Type 335 is a complete, self-contained unit which contains necessary battery supplies and balance system to operate whatever strain-gage setup may be used. Internal voltages from 6 to 90 volts in eight steps may be selected or an external voltage may be applied if desired. A front-panel meter checks internal battery condition or reads from 0 to 100 volts when an external supply is used. The Type 335 includes provision for one or two strain gages of any impedance or four gages of 120, 500, 1000, or 2000-ohms impedance. Precision calibrating resistances to supply multiplying factors from 0.1 to 100 may be switched in to calibrate the bridge in microinches per inch. A clearly marked calibration chart is permanently attached to the side of the instrument for reference. A precision, 10-turn potentiometer is provided to balance out discrepancies in gage resistance and achieve an initial condition of zero output voltage from the bridge.

The Type 332 differential transformer control is a complete self-contained unit designed for use with commercial differential transformers in the medium audio-frequency range. When used with the Type 324 cathode-ray oscillograph, the Type 332 is capable of measuring static or dynamic displacements in the region of plus or minus 0.000025 in. (25 microinches) to 0.1 in. per major scale division of deflection. The Type 332 with the proper differential transformer and cathode-ray oscillograph becomes an extremely useful dynamic or static micrometer, with frequency response extending from d-c to 1 db down to 1000 cps.

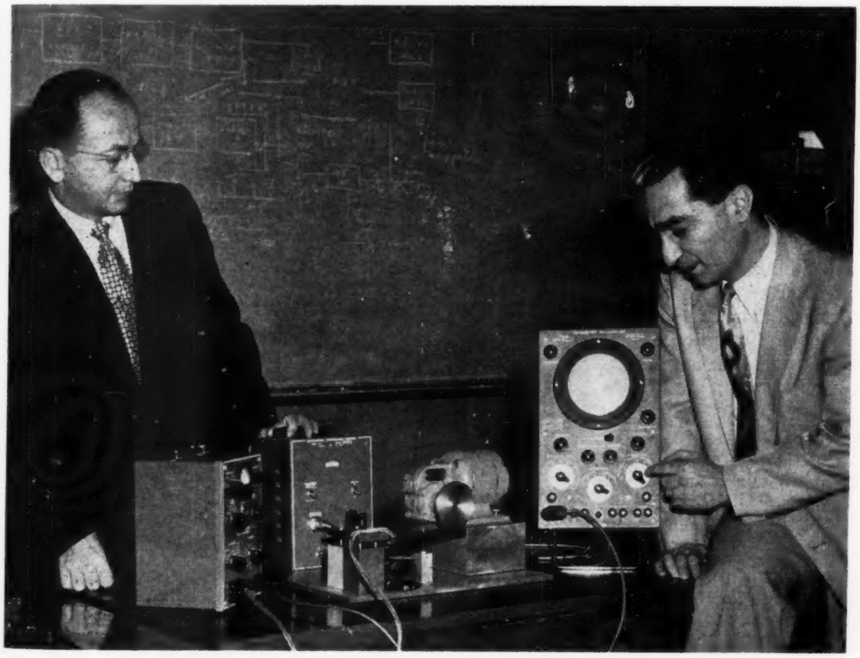


Fig. 16 In this demonstration-test setup for strain measurement the Du Mont Type 335 strain-gage control, *left,* supplies d-c power to the strain gages mounted on the test specimen. The motor-driven cam deflects the free end of the specimen, causing the surfaces upon which the gages are placed to be stretched (upper surface) or compressed (lower surface). The strain gages, permanently cemented to the specimen, convert these surface strains to minute changes in output voltage. The output from the strain gages is applied directly to the input of the vertical amplifier of the Type 324 oscillograph (*right*). Variations in this output, as the cantilever beam is moved by the cam, appear as vertical movement of the spot on the cathode-ray tube in the Type 324. This deflection can be calibrated directly in terms of microinches per inch, by utilizing the calibration signal supplied by the Type 335 strain-gage control. The Type 332 differential transformer control, *center,* is used for measuring static or dynamic displacements. Shown with the instruments are Dr. P. S. Christaldi, *left,* and E. G. Nichols of the Du Mont Laboratories.

Column Research

A FUND of new and valuable information on the behavior of columns has been accumulated during the past six years in an active research program conducted by the Column Research Council, an Engineering-Foundation-sponsored project. ASME is one of the Founder Societies that make up the Foundation.

In the light of the Council's findings, the jesting reference to the engineers' "factor of safety" as a "factor of ignorance" turns out to be anything but a jest, a Foundation report states. All engineers know that because of the inadequacy of our knowledge most structures are overdesigned with resulting waste of material. They also know that, despite the overdesign, an occasional structure fails. To increase knowledge in the field so that even the infrequent failures can be eliminated and, at the same time, to conserve the materials now wasted by overdesign, two courses are open. In the one the competent and aggressive engineer can stick his neck out and design to a narrower margin of safety. The other course involves the more certain but more expensive method of controlled experiment, the report notes.

Formation of Column Research Council

Columns, the basic load-bearing members of most structures, have long been designed by formulas based on tests on small structures. These tests, however, bear little relationship to the modern structures to which the formulas are applied. Engineers have been aware of this difficulty, but have realized that the studies and experiments needed to provide a basis for safer and more economical design were beyond the scope of any single individual or organization. It was to cope with the situation that the American Society of Civil Engineers proposed the formation of a Column Research Council. With the sponsorship and

financial assistance of the Engineering Foundation, the Council was organized in 1948. Since that time the Council has been under the chairmanship of Shortridge Hardesty, a member of ASCE and senior partner in the consulting firm of Hardesty and Hanover.

As a first step in formulating a rational research program, the Council sought information from a large and representative group of structural engineers as to the problems in column behavior, and in the buckling of metallic parts in general, which most needed solution. The research projects undertaken by the Council with the results of this survey in mind will ultimately lead to the revision of existing design formulas.

12 Projects in Progress

Typical of the Council's researches is the work that has been carried on during the past year on 12 projects at nine universities. These projects include columns in continuous frames; buckling of rigid-joint structures; analysis and design of columns in trusses and frames; effect of initial eccentricity on column capacity; built-up columns; lateral buckling of channels, I-beams, and Z-beams; inelastic instability; torsional buckling of columns; lateral buckling; interaction of compression and bending forces; stability of bridge chords without lateral bracing; and the influence of residual stress in rolled columns.

It is expected that all these subjects will be considered by the Council's new Committee on Practical Applications, and that most of them will yield recommendations for future design practice. The Committee on Practical Applications was set up in 1953 when it seemed that the time had come to give more emphasis to the practical application of the results of the Council's researches. Jonathan Jones, a member of ASCE and retired chief structural engineer of the Bethlehem Steel Company, was made chairman of the committee.

Commenting on the aims and activities of the new committee, Mr. Jones stated that, "In the design and compression members we have to a large extent coasted along, using rules and formulas derived from experiments made and deductions drawn long ago. We have established the rules either for average cases, meaning that some structural sections are not as well protected as they should be, or we have established them for the 'worst case,' thus wasting material in applications less severe."

According to Mr. Jones, this situation was not too bad "when designing was largely in the hands of experienced engineers who could take responsibility for departing from conventional rules when they considered it necessary. But as of today these rules have very generally been frozen into law through building codes and formal contracts. Furthermore, designs are often made by and under the direction of men who have had no connection with the formulation of the rules, and a departure from these rules is not expedient and, in many cases, not legally permissible."

Typical Examples

As typical examples, Mr. Jones cites "the 'column formulas' of the American Railway Engineering Association for compression members in bridges, and of the American Institute of Steel Construction for those in buildings." The AREA formula was derived theoretically from a limited number of comparatively small-scale tests on single columns. Mr. Jones points out that this result holds good only for a specific set of end conditions. However, the resulting formula was applied to various structural members and to individual sections, and the AISC formula was later adapted from it to permit lower factors of safety in buildings.

It is generally conceded, says Mr. Jones, that these formulas have the virtue of simplicity and that there generally has been some factor of safety wherever they have been applied. Most engineers, however, recognize that in the interest of obtaining greater safety for the same money, or the essential safety for less money, these simple rules should be restricted to the cases they fit best and be supplemented by additional or different rules to cover other important conditions.

The Council's research program has been planned to meet this situation, and during the six years that it has been under way much valuable new information has been developed. According to Mr. Jones, the new Committee on Practical Applications "without doubt. . .should soon be able to define practical applications of, and recommend rules of practice for, the work that the Council has been doing in the field of compression members for bridges and buildings."

Co-Operative Research

The Column Research Council is an excellent example of co-operative research on a problem of interest to widely differing groups. It is also an excellent example of an Engineering Foundation project. In addition to playing its typical "catalytic" part in getting the Council started, the Engineering Foundation has continued to sponsor and support it and has contributed $20,500 to its organization and subsequent research work. As with most Foundation-sponsored projects, however, the major portion of the funds for the Council's program ($170,000) has been contributed by industrial companies and organizations directly concerned with improved structural design.

The Council itself is a technical board of some 50 members representing technical societies, trade groups, and industries. It meets annually in New York, N. Y., for two or three days in May, to hear its various committees report and to plan future work. The Council's headquarters are at Lehigh University, Bethlehem, Pa., and Lynn S. Beedle, assistant director of the Fritz Engineering Laboratory there, is its secretary.

Industrial-Machinery Exhibit

A UNIQUE educational exhibit of basic industrial machinery was recently opened to the public by Worthington Corporation at 99 Park Ave., New York, N. Y.

The new exhibit, a permanent one, illustrates basic operating principles of machinery related to business, industrial, community, and home life.

The exhibit explains basic physical and scientific problems, showing how these principles work in industrial and domestic applications.

It is divided into five main sections: (1) Basic principles and applications; (2) home-comfort exhibit; (3) products for industry, business, and the home; (4) construction equipment at work; and (5) "Worthington City."

A row of three-dimensional panels illustrates the principles and applications for: (*a*) making steam power, (*b*) generating electricity, (*c*) internal-combustion op-

eration, (*d*) mechanical-power transmission, (*e*) pumping, (*f*) gas compression, and (*g*) refrigeration.

The home-comfort display represents home-comfort products available to the consumer for making life more pleasant at home and at business. Actual products included are a Worthington year-round residential conditioner, a room air conditioner, and $7^1/_2$-ton and 3-ton commercial packaged air-conditioning units. A Mueller Climatrol gas-fired boiler, a gas warm-air furnace, and a gas-fired incinerator are also on display.

These units are all illustrated to show how they fit into home construction. A working exhibit shows the actual operation of an air conditioner by the use of neon tubing.

Another display illustrates applications of Worthington machinery and equipment serving industrial and community life. Products included are the Monobloc pump, reciprocating steam pump, rotary pump, tank-mounted vertical air compressor, welding positioner, steam turbine, and Allspeed drive.

Fig. 17 Visitors at Worthington Exhibit are shown looking over three-dimensional display of Worthington City. In the background is the home-comfort display.

By viewing these machines, which are cut away to show the internal mechanisms, the visitor will understand the adaptation of the demonstrated basic principle to the machinery displayed. Color photographs illustrate the products in use in industry, business, and the home.

In the middle of the exhibit is a three-dimensional display, "Worthington City." Illuminated color photographs above each related activity in the composite model indicate where Worthington products are used in the many phases of industrial and community life. Represented are the industrial plant, marine operations, construction crews, air-conditioned office buildings, water and sewage works, power-generating plants, railroads, and homes.

Army Package Reactor

A LUMP-SUM contract to design, build, and test-operate a prototype "package" nuclear power plant for military use was awarded to the American Locomotive Company, according to an Atomic Energy Commission announcement. The contract is the first of this kind to be let on a fixed-price basis and as such is an important step in the development of power-reactor technology.

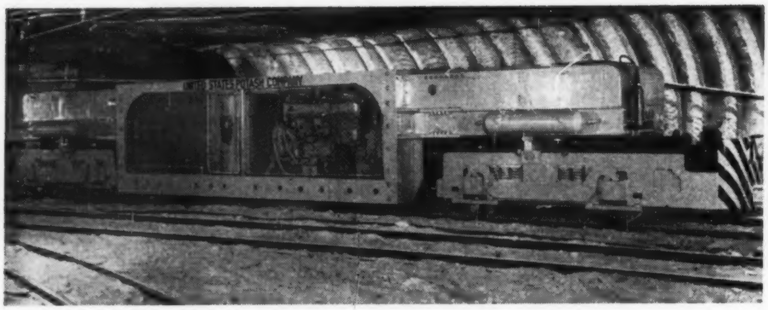
The contract price is $2,096,753. This cost will be shared by the AEC and the Department of the Army on an approximately equal basis.

The plant, which has been designated the Army Package Power Reactor (APPR), will be built to provide construction, operation, and maintenance information and to demonstrate both the capabilities and limitations of such plants. The design of the APPR is based on studies by the Oak Ridge National Laboratory which established the feasibility of developing such a plant.

The project, as recently described by Maj. Gen. Samuel D. Sturgis, Army Chief of Engineers, is designed to develop a power-reactor plant, with components transportable by air, which can be used at remotely located bases.

Such a plant would reduce the amount of bulky conventional fuels that must be transported to support a military operation.

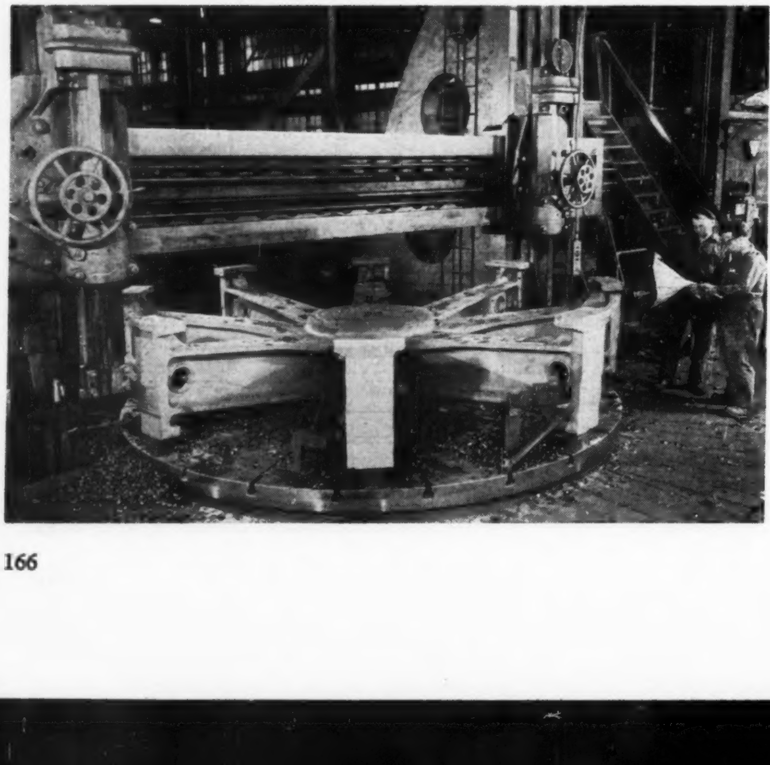
The prototype nuclear reactor will have a capacity of about 2000 kw of electricity. Future plants based on this experiment could be built to provide space heating in addition to electricity. The prototype will be built at Fort Belvoir, Va., site of the Army Corps of Engineers Training Center, where it will provide a training facility which can be integrated into the Engineer Training program of the Army.



Mine Locomotive. A small, powerful diesel-electric locomotive not much higher than an automobile is now in operation underground at the U. S. Potash Mine, Carlsbad, New Mex. Just 6 ft high and 47 ft long, it can travel 37.5 mph and pull 800 to 1000 tons on a level track. To get the locomotive into the mine, it had to be dismantled and reassembled underground. The locomotive was built at General Electric Company's Locomotive and Car Equipment Dept., Erie, Pa.

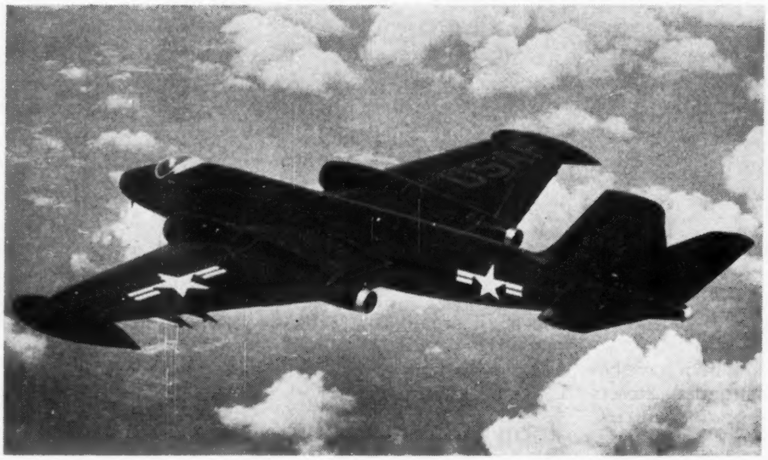
Engineering Developments ... at a Glance

Corrosion Protection. Aluminum ship-hull anodes are shown at *right*, installed on the stern area of the *S.S. Alcoa Clipper*, protecting it from corrosion-erosion attack. The anodes were cut from Alcoa anode plate which was developed by the Aluminum Company of America. A total of 385 lb of anode metal was used on the ship hull which provided protection for approximately one year. Designed primarily for the cathodic protection of steel ship hulls in sea water, the aluminum anodes provide better protection than the zinc anodes previously used.



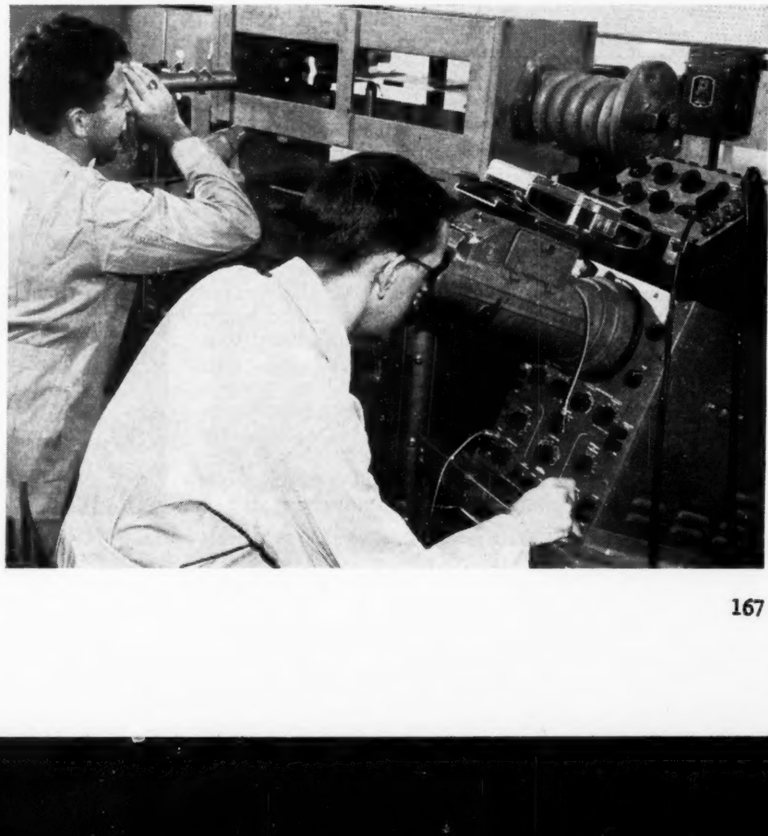
Vertical Boring Mill. A 16,000-lb, 170-in-diam spider for a turbogenerator is shown being rough-milled in this vertical boring mill at the Union Steel Castings Division of the Blaw-Knox Company, Pittsburgh, Pa. The 14-ft table on which the spider is being turned at the rate of 150 fpm, mills castings up to 304 in. in diam. Maximum operating height of the machine is 127 in.

Mobile Missile Launcher. Ready to fire a Martin B-61 Matador Missile, is this mobile launching equipment. Called a "Zero Length Launcher," this launching device consists of a specially constructed semitrailer with a motor generator, blower, hydraulic pump, and a wing rack. The missile is mounted on the launcher by a three-point suspension. Two ball-and-socket supports at the front point the weapon upward at a 15-deg angle. The rear support is in the form of a bolt that keeps the missile from moving until full power is attained at which time the bolt shears and allows the missile to take off. The launcher operates in an area of only 100 ft sq without the use of a runway. Only one part of the device moves during the operation and that only a few inches.



Swift Jet Bomber. This swift light bomber shown cruising above the clouds is similar to the Martin RB-57's recently delivered to the 12th Air Force in Germany. The RB-57 is capable of speeds not usually associated with bombers—more than 500 knots. It has a range of more than 2000 miles, can climb higher than 45,000 ft, and can take off and land in unusually short distances. An unusual feature is a rotating bomb door forming part of the fuselage which will make possible greater accuracy during bombing attacks than previously possible.

Jet-Blade Testing. General Electric engineers using this combined stress joint tester are able to simulate the stress and strain put on jet blades by vibration caused in flight by air going through the engine and by the centrifugal force of the revolving wheels. Large spring at *right* is capable of applying more than 18 tons of horizontal force on the blade similar to that caused by centrifugal force, while the vibrating section supplies the vertical vibrations. At *left*, a reading is being taken of the amplitude of the vibrations. At *right*, the test is being followed on an oscilloscope screen.



European Survey

Engineering Progress in the British Isles and Western Europe

J. Foster Petree,[1] Mem. ASME, *European Correspondent*

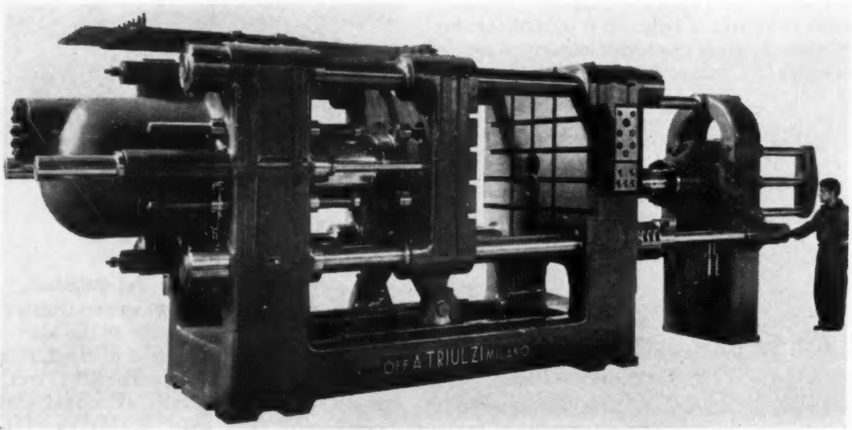


Fig. 1 Triulzi die-casting press, a direct piston-lock type with a locking force of 1200 tons

Cold-Chamber Die-Casting Press

The swarms of miniature motorcycles, which have become such a feature of Italian city and suburban streets and are now spreading to other European countries, have many of their parts formed of light-alloy die castings, and this method of metal forming is rapidly spreading to other manufactures. The Italian machine-tool industry, therefore, has been devoting considerable attention to the production of die-casting machines, one of the latest types, which was shown at the European Machine Tool Exhibition at Milan, being the Model 30M constructed by the firm of Ambrogio Triulzi of that city. It is shown in Fig. 1. The machine is of the direct piston-lock type and can exert a locking force of 1200 tons. It is hydraulically operated, the working pressure of the water being 2130 psi.

A centrifugal pump is used for prefilling and a horizontal ram pump with an air-loaded accumulator provides the closing pressure. The pump has a capacity of 26 gpm and the accumulator holds 220 gal. The machine is arranged for horizontal injection, there being three injection positions, one on the center line and two below it. Control is by push button which initiates an automatic cycle of injection, opening and ejection, a timer regulating the sequence and duration of the movements. The four horizontal tie bars, 8 in. in diam, are widely spaced to afford easy access to the platens, the space between them being 3 ft 7 in. × 4 ft 11 in. The maximum platen opening is 5 ft 5 in., and the stroke of the main ram is 3 ft 3 in. The injection force is 100 metric tons.

[1] Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

Form Grinding With a Tool Grinder

The N. V. Nederlandshe Machinefabriek "Artillerie-Inrichtingen," of Zaandam, Holland, have marketed for some time a tool and cutter grinder known as the U 2, which was designed for general toolroom purposes. They exhibited at Milan a modification of this machine, which can now be used for form grinding as well as for

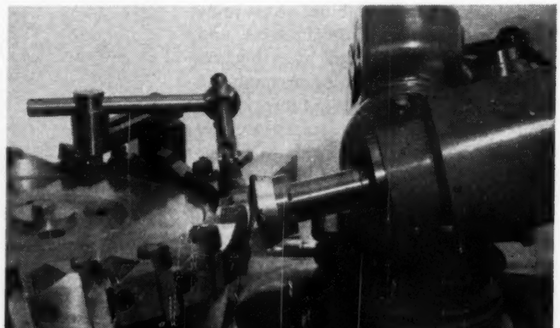


Fig. 2 NV Nederlandshe Machinefabriek "Artillerie-Inrichtingen" form and tool grinder

tool and cutter work. It is mounted on a cast-iron box base into which the vertically adjustable column, carrying the grinding wheel, retracts; the column has a vertical travel of $10^1/_4$ in., giving a maximum distance between the center of the spindle and the top of the table of $12^5/_8$ in. The horizontal stroke of the table is $16^1/_8$ in. Grinding wheels up to 6 in. in diam can be accommodated and the spindle has a speed range from 3000 to 6000 rpm. The column is enclosed in a protective bellows to exclude swarf, etc.

For use as a form grinder the machine is provided with a cross slide running on rollers in hardened guides, a guide finger mounted on the frame, and a slotted strip for attaching a template to the longitudinal slide. The nut on the cross slide is disengaged, and the guide finger is then kept in contact with the template by a weight suspended at the back of the machine. By mounting a swiveling wheelhead on the top of the column, as shown in Fig. 2, the machine can be employed to grind the teeth of inserted-tooth milling cutters, to grind broaches, and for vertical and internal form grinding.

Semiautomatic Twin Lathe

A SEMIAUTOMATIC lathe, designed for machining in quantity the many small components for optical and other instruments, clocks, etc., was shown at Milan by Kummer Freres, of Tramelan, Switzerland. As shown in

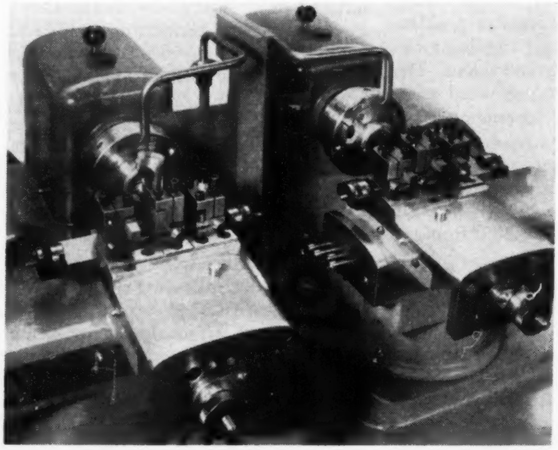


Fig. 3 Semiautomatic lathe with turn spindles and toolheads

Fig. 3, it has twin spindles and toolheads, so that a constant output can be maintained by a single operator. The two heads are completely independent of each other, and all that the operator has to do is, on each head in turn, to load the component into a pedal-actuated chuck and engage the slide motion and drive by depressing the starting handle. The lathe stops automatically at the end of the working cycle. The driving motors, their control and operating mechanism, and the lubricating and coolant system are contained in the box base. Machines intended for working in steel or cast iron are provided with steplessly variable-speed transmissions, giving a range from 325 to 2800 rpm, or from 410 to 3500 rpm. For working on light alloys, brass, etc., the speed range is usually 2800 rpm, but sometimes is increased to 3500 rpm. The movement of the tools in the horizontal plane is controlled by two slides, set at 90 deg and each operated by a cam. All the forward motions of the tool carriers are positive, the cam feeding the carriage forward against the work. The tool is withdrawn by a spring. The toolholders are adjustable radially, axially, and in height. The heads are separately driven, each by a 3-phase motor of 1.5 hp. The cams are driven by V-belts on stepped pulleys; normally four cam speeds are available for each speed of the working spindle, but the drive can be adapted to give eight cam speeds instead of four, if required. A number of special chucking devices have been devised for special purposes, but the ordinary collet chuck will grip any regular shape, rectangular, elliptical, or round.

Profile Grinder

KUMMER Freres also exhibited a neat design of profile grinder, illustrated in Fig. 4. It is made in three sizes, the RE80, RE125, and RE150. The table is driven hydraulically, thus providing for instantaneous speed variations and slides between automatically lubricated inverted V-guides. The reverse motion can be adjusted independently for each direction. For adjustment or when grinding against stops, the table can be driven at two different speeds, engaged by means of a handwheel which is automatically disengaged when the machine traverse is used. The wheelhead spindle is driven by a d-c motor, variable-speed regulation between 110 and 1100 rpm, being provided by a Ward-Leonard control system. The work spindle is driven by a V-belt. For quantity production, the workhead drive, the stop, and the opening and closing of the chuck are all actuated by the main control lever. The lubricating oil and coolant tanks are contained in the base, together with a filter of large capacity. The coolant flow is automatically started and stopped each time the wheelhead is advanced or withdrawn. The heights of the centers, for the three sizes of the machine, are 80 mm, 125 mm, and 150 mm, respectively, as indicated by the type numbers, and the distances between centers are 400, 650, and 1250 mm, the maximum lengths of the work surfaces being 50 mm less in each case.

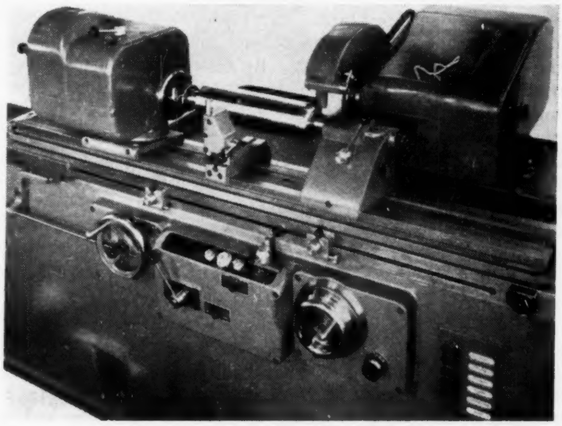


Fig. 4 External profile grinding machine—model RE150

ASME Technical Digest

Substance in Brief of Papers Presented at ASME Meetings

View of the C-130A on the ground. Upswept tail provides ample truck clearance when loading.

Aviation

Lockheed C-130A Transport in the Air-Mobility Era, by R. W. Middlewood, Lockheed Aircraft Corp., Marietta, Ga. 1954 ASME Annual Meeting paper No. **54—A-227** (multilithographed; available to October 1, 1955).

The C-130A military transport has earned a place in the future national-growth potential because of careful attention to its development by the Air Force, the Army, and the manufacturers. Some high lights, during the development of the C-130A, are outlined.

Simplicity, reliability, and rugged construction were the primary factors in the design philosophy. Other prime objectives were economy of manufacture, operation, and maintenance.

The one-engine-out condition fixed the need for four engines. Because operational economy was a goal, the turboprop engine was chosen for its long-range performance characteristics at high altitudes. The Allison T56-A-1 engine rated at 3750 eshp combined with the Curtiss-Wright turboelectric, full-feathering, reversible, three-bladed propeller met the requirements very satisfactorily.

The long-range and high-altitude factors meant a high aspect-ratio wing. A cargo floor at truck-bed level placed the wing high on the fuselage. We settled for a wing of 10 aspect ratio, 132-ft span, and 1745 sq ft in area. A relatively conventional arrangement of cargo space, which includes troop seating and litter tiers, was evolved. Wind-tunnel tests solved the aerodynamics problem of fairing the aft fuselage containing the in-flight operable ramp and door. The flat, elliptical end section provided suitable stiffness for the empennage, expanded rapidly into a cone-shaped section, and faired into the primary fuselage smoothly. The over-all fuselage length turned out to be 95 ft. The tip of the single vertical tail is 38 ft from the ground.

As the general arrangement took form, the empty weight settled at 57,500 lb, a gross weight of 108,000 lb with a design pay load of 25,000 lb. The alternate gross weight became 124,200 lb with a much higher pay load at acceptable, reduced-load factors.

Minimum-performance requirements were improved on by careful attention to the many facets of detail airplane design. Predicted average cruise speed is 20 per cent faster; normal power, ceiling, and rate of climb are 35 per cent higher; normal power, one-engine-out ceiling, and rate of climb are, respectively, 35 per cent higher and 55 per cent faster; take-off distance with maximum power is 25 per cent less; and finally, landing distance, using brakes only, shows a 40 per cent decrease. Range and pay-load factors formed the keystone design parameters.

The airplane, even with its relatively larger size and weight, has the flying qualitities of a much smaller airplane. Large airplanes are usually slower in responding to the pilot's controls because of their larger inertias. The control forces on the C-130A are very light and even at low flying speeds, the combination of light forces with high inertia seldom gives the pilot any impression of sluggishness.

Capabilities and Operating Costs of Possible Future Transport Airplanes, by T. V. Jones, Northrop Aircraft, Inc., Hawthorne, Calif. 1954 ASME Annual Meeting paper No. **54—A-217** (multilithographed; available to October 1, 1955).

Rand has completed a study which provides knowledge of airplane characteristics and includes a sample operational analysis to illustrate how aircraft should be compared in performing a logistics job. The study consists of the design and analysis of many possible future transport aircraft which could be operational in eight to 10 years if the necessary engine and airframe development were carried on from the present time. The direct operating cost per ton-mile and the take-off gross weight are determined for these airplanes, which have been designed to differ from each other in at least one of the following characteristics: Design-point payload, 25,000 to 150,000 lb at several cargo densities; design-point range, 1500 to 3500 nautical miles; design cruising speed, 180 to 490 knots; required field length, 2000 to 6000 ft; engine type, compound-reciprocating, turboprop, and turbojet.

Each airplane can carry its design-point pay load as far as its design-point range when operated at its design cruising speed. Specification of a design-point pay load and a design-point range does not signify that the airplane must be operated with this pay load at this range. Each airplane in this study can carry more than the design-point pay load by reducing its range and can fly farther than the design-point range with less than the design-point pay load.

This study does not attempt to indicate a preferred airplane, as airplane choice is dependent on the specific logistics job to be accomplished. Nevertheless, some general conclusions regarding possi-

ble future transport aircraft can be set forth:

The cruising speed at which lowest direct operating cost per ton-mile is achieved depends on the type of engine powering the aircraft, but is independent of pay load and range.

Airplanes powered by turboprop engines provide lower direct operating cost per ton-mile than airplanes powered by compound-reciprocating or turbojet engines for any combination of design speed, pay load, and range considered.

Large airplanes (resulting from long design range and heavy-design pay load) have lower direct operating cost per ton-mile than do small airplanes. The large airplanes are also less sensitive to variation in operating range both from the standpoint of cost per ton-mile and air-lift capability.

Selection of a preferred airplane should be based on the cost to perform the total logistics job by a fleet of the airplanes rather than on the ability of one airplane to fulfill some single pay-load-range requirement.

The cost of air transportation can be considerably lower in the future than it is today if a well-integrated plan for airplane and engine development is aggressively pursued.

Background of Boeing 707 Jet Transport, by G. S. Schairer, Boeing Airplane Company, Seattle, Wash. 1954 ASME Annual Meeting paper No. 54—A-263 (multilithographed; available to October 1, 1955).

This paper outlines the development of the design of the Boeing 707 jet transport. The research that accompanied the final design, including landing gears, wing placement, and engine tests, is described.

In choosing jet engines, the paper states, the designers refuted the belief that jet propulsion was not economical, finding that the thrust horsepower obtained per pound of fuel consumed increases very rapidly with speed.

Calculations of the direct operating cost of 707 transport airplane have been made, and show that the airplane can be operated at substantially lower direct operating costs than current four-engine transports. Primarily, this low cost comes about as the result of the very large work or earning capacity of fast jet-transport airplanes. The jet transport, because of its increased speed and increased size, has many times the carrying capacity of current four-engine transports. The cost of a jet-transport airplane, even in initial quantities, when compared on the basis of cost per unit-of-work or earning capacity, is essentially the same as the unit cost of current transports. When a substantial number of jet transports have been built, the cost will be materially less per unit-of-work capacity than for current types.

A logical application of engineering-design principles has permitted the development of a very high-performance jet-transport airplane which combines reliable, proved design features into a very economical airplane. We can look forward to having a long era of fast, economical, and comfortable jet transportation with the Boeing 707 jet-stratoliner airplane.

The Helicopter's Role in Amphibious Operations, by A. J. Clapp, U. S. Marine Corps School, Quantico, Va. 1954 ASME Annual Meeting paper No. 54—A-228 (multilithographed; available to October 1, 1955).

Marine Corps planners first became conscious of the potentialities of the helicopter shortly after the first Eniwetok atomic-bomb tests. It was apparent that an amphibious assault force of the future would not only have to reckon with the enemy capability of using nuclear weapons, but also would have to consider methods of exploiting the advantage gained by using them against the enemy. To defend against and effectively exploit the atomic capability, it would be necessary to inject added speed, mobility, and dispersion into the operation. It was envisioned that the helicopter might be the key to these factors. Tried and proved, helicopters were more than equal to the task. In addition to providing a new concept of amphibious ship-to-shore movement, helicopters have made it possible to attack the enemy's "third flank" by vertical envelopment.

The most obvious advantage of the helicopter is range. In all aircraft employment—rotary or fixed-wing—a compromise must be reached between fuel load and pay load. Helicopters have the same world-wide range as the fleet that transports them. This is because their fuel load need be just enough for a ship-to-shore round trip.

Besides range, there is a very definite tactical advantage attached to employing helicopters. As paratroops jump into battle, they tend to become scattered, making the problem of control extremely difficult. In comparison, helicopter-borne troop units are landed intact and ready to fight. This permits immediate control by the troop leader over his men during the most critical period of the assault.

When troops are delivered by helicopter, it is not necessarily a one-way trip. Helicopters could return and move the troops to another tactical locality—or retrieve them entirely. Casualties could be helicopter-evacuated to hospital ships offshore, as they were in Korea. This is important from a lifesaving standpoint and is far more economical than moving a field hospital ashore.

The standard transport helicopter in

Sikorsky HRS, standard Marine Corps transport helicopter, is used as a flying crane when it transports items that are bulky, or when it is desirable to rapidly load or unload cargo as was the case in Korea

the Marine Corps is the Sikorsky HRS. Normal load is about six or seven fully equipped troops, depending on the distance they are to be carried; or it can carry a comparable weight in supplies, either internally or externally.

As a replacement for the HRS, we shall eventually have the Sikorsky HR2S. It is equipped with "clamshell" doors to facilitate loading and unloading. It has twin reciprocating engines mounting in pods attached to wing stubs, and they are geared to a single five-bladed rotor. The HR2S is designed to transport between 20 and 36 troops, depending upon the distance they are to be transported, and has a speed of over a hundred knots. It can be operated from escort carriers.

The Convair YC-131C Turbo Liner, by B. J. Simons, Convair, San Diego, Calif., and P. J. Lynch, Convair, Fort Worth, Texas. 1954 ASME Annual Meeting paper No. **54—A-229** (multilithographed; available to October 1, 1955).

The Convair YC-131C Turbo Liner is a modified standard model 340 airliner to serve as a flying test bed for Allison YT-56-A-3 turboprop engines. Successful flight operations have opened tremendous new potentials for this high-performance airplane. Early this summer the modification of two CV340 airplanes into YC131C's was completed at the Convair plant in Fort Worth, Texas. The first flight took place in May, 1954. This paper presents a detailed description of the modification work and also a summary of the flight testing accomplished by Convair.

The commercial Model 340 was designed structurally for a maximum weight of 53,200 lb. The present airplane is certified by the CAA for a take-off weight of 47,000 lb and a landing weight of 46,500 lb. Since the purpose of the airplane was a test vehicle no necessity existed for increasing the gross weight. Future test programs will probably include performance at increased gross weights.

The published power on the production T-56 engine is 3750 equivalent shaft horsepower for take-off rating. The YT-56-A-3 engine in the YC-131C has been operating at an Air Force restricted power below this value. With the production Allison specification power the YC-131C will have a high speed of 338 knots. This speed will be obtained at 25,000 ft with military power and a 43,000 lb average gross weight. The range at an operating speed of 287 knots with 80 per cent normal rated power at 30,000 ft and full fuel will be 1710 nautical miles.

The service ceiling (rate of climb 100 fpm) with two engines operating is 36,300 ft and with one engine is 18,000 ft.

A take-off at 47,000 lb gross weight should require 2710 ft to clear a 50-ft obstacle. Landings have been made in which the use of reverse thrust resulted in a landing roll of 700 ft.

The potential of the airplane at 53,200 lb take-off weight allows considerable increase in performance. By adding more fuel in the wing and with wing-tip tanks, the all-out range can be increased to 3000 nautical miles. Even with a 24,000-lb pay load, a cargo version would have a range of 1700 nautical miles.

Comparing the performance of the YC-131C with the Convair liner is not easy. Comparable cruise conditions involve entirely different engine-power settings at different airplane altitudes. If basic assumptions of equal airplane weight, actual air-line cruise power on the reciprocating engines, advertised cruise-power settings on turboprop engines, and optimum altitudes for each type engine are assumed, a comparison would make the YC-131C 75 mph faster.

The Role of Air Cargo in Modern Logistics, by J. N. Sammons, U. S. Air Force, Washington, D. C. 1954 ASME Annual Meeting paper No. **54—A-216** (multilithographed; available to October 1, 1955).

From the military point of view, the cargo aircraft is useful only to the extent that it will mesh with and contribute to the accomplishment of the logistics mission and objectives. This paper discusses the military air-cargo problem in general, with specific reference to packaging, materials handling, air terminals, desirable characteristics of cargo-type aircraft.

Problems in Evaluation and Maintenance of Jet-Engine Fuel-Metering Accessories, by L. A. Wilson, Department of the Navy, Bureau of Aeronautics, Washington 25, D. C. 1954 ASME Annual Meeting paper No. **54—A-70** (multilithographed; available to October 1, 1955).

Using carburetors for reciprocating engines and fuel-control units of turbojet engines as examples, attention is called to the principal problems in the evaluation and maintenance of engine accessories.

Fuel contamination is cited as a major cause of failure. The need for improved test equipment and techniques, whereby adjustment in the shop can reduce the amount of testing which must be done on the engine, is urgent with those who must overhaul and maintain accessories.

More specifically, reduction of the maintenance load requires that engines be made to perform more reproducibly, that the fuel-metering accessory be improved, and that test equipment be developed whereby the latter can be evaluated under conditions of rapidly increasing and decreasing engine speed. Although much progress has been made along these lines, a great deal more would be imperative for satisfactory maintenance in wartime.

Dynamic Testing of Jet-Engine Fuel Controls Using an Engine Simulator, by W. S. Bobier, Vickers Inc., Detroit, Mich. 1954 ASME Annual Meeting paper No. **54—A-136** (multilithographed; available to October 1, 1955).

The increasing complexity of fuel systems for jet engines has brought about the need for an improved fuel-system calibrating and testing technique. This requirement has led to the development of a jet-engine simulator for dynamic testing of fuel systems.

The device described in this paper consists of an analog computer and a hydraulic transmission combined in such a way that they respond to the fuel delivered by a fuel control in the same manner that an actual engine for which the fuel control is designed would respond.

The simulator can be used to test control systems for a wide variety of prime movers such as turboprop engines, diesel engines, and gas turbines as well as jet engines. The usefulness of this device need not be restricted to calibrating fuel controls. The automatic factor or chemical plant of the future may have use for a high-response device that can produce an output speed signal of considerable horsepower, yet can be controlled by an analog computer capable of relating several linear or nonlinear variables to produce the correct end result.

The engine simulator is capable of giving fuel controls a higher degree of calibration than is possible on presently used production test stands. The usefulness of the engine simulator in the jet-engine field is not restricted to production testing of fuel controls. The flexibility of the computer and wide range of speeds and power available from the transmission make this device a valuable research tool for developing and testing fuel systems for new engines.

Machine Design

Rational Thickness Design for Pressure Vessels, by P. M. Stafford, Mem. ASME, South Dakota School of Mines & Technology, Rapid City, S. Dak. 1954 ASME Annual Meeting paper No. **54—A-84** (multilithographed; available to October 1, 1955).

In pressure-vessel design above certain proportions the usual methods of providing for increased load capacity cannot be applied economically. Appreciable improvements in material economy can be accomplished by shrink-fit construction of pressure vessels requiring diameter ratios in excess of $R = 2.5$.

A method for computing rational shrink-fit dimensions is presented.

An example is demonstrated in which a reduction of wall thickness from 9.25 in. to 5 in. is accomplished. In this case the working pressure and design stress are, of course, unchanged.

No claim is made, however, that the method will result in the maximum material economy that may be possible.

Bracing Rectangular Tanks, by L. D. Jennings, Mem. ASME, Westinghouse Electric Corporation, Sharon, Pa. 1954 ASME Annual Meeting paper No. **54—A-83** (multilithographed; available to October 1, 1955).

The rectangular tank is usually not the designer's first choice when a pressure vessel is required, because the large flat walls are difficult to brace. However, there are applications where it becomes more economical to use the rectangular tank although additional bracing may be required. A power-transformer case is such an application.

The transformer case is actually an unfired pressure vessel. Unlike most pressure vessels it must withstand both internal and external pressures, since external pressures resulting from full vacuum may be used during the processing of the transformer and high internal pressures may be experienced should a fault occur. During the normal operation of the transformer the internal pressure may vary from 1 to 2 psi negative and from 6 to 8 psi positive pressure referred to atmospheric pressure.

The designer of a rectangular tank may use thick walls with relatively few braces or he may choose to use more wall braces with a thinner tank wall. Economics and the importance of the tank weight determine the final design.

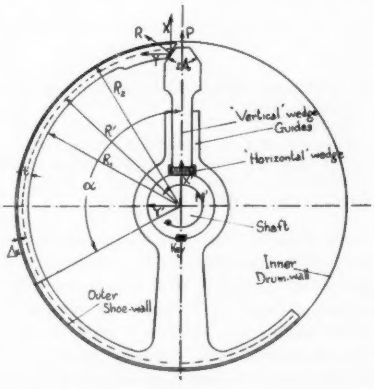
The walls, the cover, and the bottom of a rectangular tank must withstand operating and test pressures without excessive deflection. The cover, the bottom, and the walls are all flat rectangular plates and they may be treated alike as far as design is concerned. They are treated as uniformly-loaded rectangular plates having built-in edges, since the pressure upon the plate is distributed uniformly over its entire area and the edges of the rectangular plates are either the corners of the tank or a brace which acts as a supporting member.

The Design of the Expanding-Shoe Friction Clutch, by M. J. Cohen, Queen Mary College, London, England. 1954 ASME Annual Meeting paper No. **54—A-86** (multilithographed; available to October 1, 1955).

Of the three types of friction clutches currently in use, the expanding-shoe type has received little or no attention as far as a design technique is concerned. The usual procedure has been to rely on precedent and empirical formulas to evolve a clutch to transmit a required torque. This can only lead to overstiff clutches with the resultant loss of utilization of its full capacity, or to a waste of material, space, and, possibly, a superfluity of effort in the process of engaging the clutch.

The expanding-shoe type of clutch consists of a drum free to rotate about a shaft—either driver or driven—with a spider keyed to it and developing solidly and symmetrically into two quasi-semicircular shoes close around the inner wall of the drum. These shoes can be forced against the inner wall of the drum by means of a lever and wedge mechanism, thus effecting a frictional engagement between drum and shaft.

This paper gives a complete and exact treatment of the problem of the design of friction clutches of the expanding-shoe variety. The method followed is one which, from the beginning, takes all the relevant parameters of the clutch, such as dimensions, elastic properties, and the forces-moment systems to be arbitrary and then proceeds to relate them by a set of equations that illustrate the final equilibrium of the system. From the three basic equations derived, a simple and very rapid design technique is evolved which can be used reliably by technicians for the design of one such clutch to transmit a required torque.



Essential features of an expanding-shoe clutch

Section 4 incorporates the complete technique of design and can be interpreted simply without reference to the theoretical considerations leading to it in the preceding sections.

The Influence of Tap-Drill Size and Length of Engagement Upon the Strength of Tapped Holes, by C. J. Oxford, Jr., Mem. ASME, National Twist Drill and Tool Company, Rochester, Mich., and J. A. Cook, National Machine Products Company, Utica, Mich. 1954 ASME Annual Meeting paper No. **54—A-85** (multilithographed; available to October 1, 1955).

The influence of tap-drill size (minor diameter) upon the strength of threaded assemblies has been the subject of much speculation, analysis, and testing, but the results presented generally have been inconclusive or have not covered all of the many possible types of thread failure. This paper reports the results of a series of correlative tests and supporting analysis performed in an attempt to solve this problem.

The external threads were made of three different steels, ranging from soft to very hard. These were engaged with both soft and heat-treated steel and cast-iron internal threads having thread-height percentages from 25 to 95 per cent.

The ultimate strength of the assembly was measured on a tensile-testing machine. The length of engagement for these tests was equal to the height of a standard nut. Sizes used were $^3/_8$-16 UNC-3, $^3/_8$-24 UNF-3, $^5/_8$-11 UNC-3, and $^5/_8$-18 UNF-3, which are representative of common high-grade usage. For one size, the length of engagement was varied from 25 to 100 per cent of standard nut height for each thread-height percentage.

Failures can be of three types: Breakage of the external thread member, stripping of the external thread, or stripping of the internal thread. The effect of drilled-hole oversize is examined and is found to be a significant variable in some cases. Formulas are developed which extend the experimental data to permit analysis of most practical thread-element combinations. For assemblies of usual proportions and materials, it is

found that 60 per cent thread height is adequate.

Stresses and Deflections in Eccentrically Loaded Gear Teeth, by Joseph Marin, Mem. ASME, Pennsylvania State University, State College, Pa., and R. H. Shenk, Mem. ASME, Wiedemann Machine Company, Philadelphia, Pa. 1954 ASME Annual Meeting paper No. **54—A-79** (multilithographed; available to October 1, 1955).

In machine design the approximate procedures for calculating the stresses and deflections in gear teeth, as represented by the Lewis formula, are adequate for many applications. However, for gear teeth with certain proportions and for teeth loaded eccentrically the approximate methods for calculating strengths and deflections are inadequate.

This paper develops the stress-analysis and strength relations for short gear teeth eccentrically loaded. For this purpose stresses produced by torsion, transverse shear, axial compression, bending, and stress concentration were determined and the combined effect of these stresses on the strength of gear teeth was evaluated. To calculate this strength it was necessary to consider various locations throughout the gear tooth. Furthermore, the strength determination was made based on the so-called distortion energy or von Mises-Hencky theory of failure. This theory has been found to be in good agreement with test results for defining yielding under combined biaxial stresses in ductile materials.

An analysis also is developed in this paper for the determination of deflections in eccentrically-loaded short gear teeth. These deflections consider the influence of both bending, transverse shear, and torsion. A correction also is made in the equation obtained for the local Hertz deformation.

A comparison of the more exact relations for strength and deflections of gear teeth developed in this paper, with the approximate methods usually used, shows that in some cases the errors produced by use of the approximate methods may be appreciable.

Fatigue: The Problem and Some Solutions, by G. R. Gohn, Bell Telephone Laboratories, New York, N. Y. 1954 ASME Annual Meeting paper No. **54—A-87** (multilithographed; available to October 1, 1955).

Intelligent machine design requires a knowledge of the fatigue properties of materials as well as the precautions which must be observed both in design and in manufacture to insure adequate service life. In this paper the causes of fatigue are described briefly and the mechanism of fatigue failure is discussed.

Several examples are given to show that properly designed laboratory tests will yield fatigue data which can be applied to the solution of design problems.

Some precautions which will tend to reduce the probability of fatigue failure during the expected life of the machine are the following:

Since fatigue failure generally starts at or near the surface, any improvement in surface conditions such as the use of better machining practices or surfaces having a better microfinish, the use of electroplated finishes which have residual-compressive rather than residual-tensile stresses, or the use of shotpeening which puts the surface in compression will all result in longer fatigue life.

Machine parts made from good, clean, homogeneous materials, free from inclusions and voids and preferably with a fine grain size, either after heat-treatment or in the ready-to-finish anneal, will have longer life than parts made from nonhomogeneous materials, material full of voids or inclusions, or material having a coarse grain size.

In general, small-size parts will have a longer fatigue life at a given stress than will large-size parts made from the same material. Stress-relief annealing or any treatment which relieves internal stresses and all designs which reduce stress concentration to a minimum will improve fatigue life as will case-hardening, cold-rolling, or similar treatments which increase the tensile-yield strength of the material.

In any machine design a knowledge of the stress conditions is a prerequisite to long life if fatigue failures are to be avoided. If the stress conditions cannot be calculated readily, then stress-coat or photoelastic studies may be necessary to insure good design.

A Theory of Fatigue-Damage Accumulation in Steel, by D. L. Henry, Wright Air Development Center, U. S. Air Force, Wright-Patterson Air Force Base, Ohio. 1954 ASME Annual Meeting paper No. **54—A-77** (multilithographed; available to October 1, 1955).

At present there is no theoretical method for predicting the change in the endurance limit of steel specimens subjected to various numbers of cycles of overstressing at different stress levels. The theoretical and most of the experimental work accomplished thus far has been concerned with studying the change in endurance life at some stress level resulting from the accumulation of various amounts of overstressing at other stress levels.

This paper presents a simple theoretical model for predicting the change in endurance limit resulting from the accumulation of overstressing cycles at moderate levels of overstress and for moderate degrees of fatigue damage.

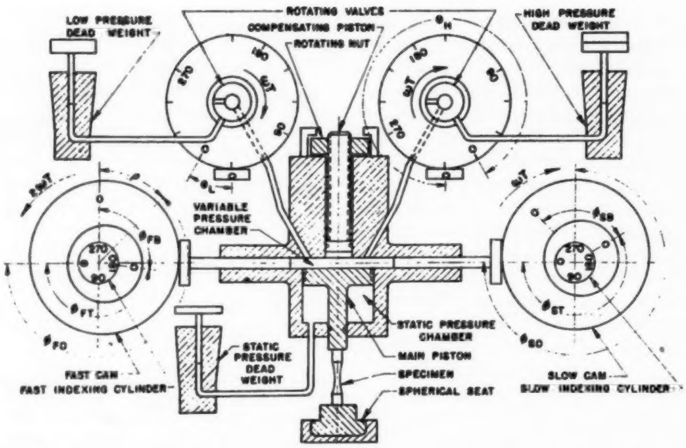
Review of the literature indicates that it is reasonable to assume that fatigue damage occurring prior to the formation of a visible crack is equivalent to an increase in a "stress-concentration factor" associated with the particular defect in the specimen which will form the fatigue nucleus. The application of simple notch-factor concepts and the use of an empirical formula for the S-N curve for steel resulted in an equation for predicting the change in the S-N curve when specimens are subjected to overstressing histories producing moderate amounts of fatigue damage.

A New Fatigue-Testing Machine Capable of Inducing Complex Stress-Time Relationships in Its Specimen, by W. L. Starkey, Assoc. Mem. ASME, and S. M. Marco, Assoc. Mem. ASME, The Ohio State University, Columbus, Ohio. 1954 ASME Annual Meeting paper No. **54—A-80** (multilithographed; available to October 1, 1955).

In recent years the demand has been for the development of higher and higher performance machines. A high-performance machine may be defined as one which performs a large amount of work in a short period of time, and is simultaneously lightweight and compact. The small, lightweight parts of such a machine are subjected to large functional and inertial forces. These induce large cyclic stresses which accumulate great numbers of cycles in short periods of time. Designs of machine parts subjected to such stresses usually involve critical fatigue problems.

One of the important methods of solving such problems consists of conducting research to gain new detailed information relative to fatigue phenomena. New and accurate knowledge of the effects of various types of cyclic stresses on the endurance properties of materials permits the revision of simplifying assumptions. This, in turn, allows required factors of safety to be lowered. As a result, machines can be designed which are small and light but yet are capable of high performance.

A fatigue-testing machine has been designed and constructed to serve as a research tool for investigating the effects of multiharmonic complex uniaxial stresses on the endurance lives of metals.



Schematic diagram of two-harmonic complex-stress fatigue-testing machine. The specimen is attached to a piston which is acted upon by a static pressure on one side and a cyclicly varying pressure on the other. The pressure variation is created by two cam-operated plungers, one of which reciprocates at twice the frequency of the other. All pressures are initially developed by a two-cylinder Bosch injection pump. All pressures are controlled accurately by dead-weight comparators intermittently connected to the hydraulic chamber by synchronized rotary valves, and by intermittent adjustment of a compensating piston which controls the volume of the variable-pressure chamber.

The machine induces in its specimen a complex stress pattern composed of the superposition of fundamental and second-harmonic sinusoidal stress-time waves. Synthesis of component stress waves is achieved by the action of independently controlled cam-operated plungers on a common volume of hydraulic fluid. The resulting time-periodic pressure acts on a piston to which the specimen is attached.

Machine-Tool Automation, by K. O. Tech, The Cross Company, Detroit, Mich. 1954 ASME Annual Meeting paper No. **54—A-82** (multilithographed; available to October 1, 1955).

Automation probably was originated years ago by the man who first conceived the idea of placing two tools on a lathe carriage to cut two diameters at one time.

From this beginning the machine-tool industry developed first single and then multiple-station machines such as turret lathes, automatic screw machines, dial-type index machines, trunnion machines, and finally transfer machines which combined more and more machining operations into a single unit. This made necessary machines with provisions for automatic locating, automatic clamping, automatic cutting cycles, and automatic material handling. So successful have these developments been that today we are reaching for the automatic factory.

Machines such as the Transfer-matic represent our present progress. This machine is 356 ft long, performs 555 machining operations, 133 inspection operations, and handles an automotive cylinder block in 7 positions, producing 100 blocks per hour. The machine is under the control of one operator.

Automation was the result of a continual development of mechanisms, hydraulics, and electric controls. It is in the continued development of these details of design that machine designers are doing the most to further the automatic factory.

Successful efforts in this direction will depend in a large measure upon ability to control down time. Automatic factories or automatic production lines cannot be tolerated unless they can be kept in production. Theoretically speaking, there is no limit to the number of operations which can be combined in one machine or process but when we consider efficiency, there is a limit. The practical limit is down time. It is in the reducing of down time and the increasing of efficiency to make possible automatic production lines that the future presents its greatest challenge to the machine designer.

There are two basic classifications of down time. The first is predictable down time, such as time for changing tools, cleaning a machine, and the like. We are making forward strides in automatic programming through the use of instrumentation to eliminate unnecessary down time for these predictable causes.

The second type of down time, unpredictable down time, which generally results from breakdowns, is of great interest to the machine designer. This type of down time can be practically eliminated for in most cases it results from poor design. To eliminate this down time, machine designers are called upon not only to develop simpler, better operating, and more rugged mechanisms, but also to co-ordinate their efforts with those of the hydraulic and electrical designers in order to arrive at a completely integrated design which will result in a minimum of down time. Machine designers concern themselves with these other elements, for the poor selection of hydraulic or electrical equipment in relation to the job which must be done, poor location of special controls on and around the machine, or poor means for operating such controls can only result in excessive down time.

Influence of "Automation" on Machine-Tool Design, by F. R. Swanson, Sunstrand Machine Tool Company, Rockford, Ill. 1954 ASME Annual Meeting paper No. **54—A-81** (multilithographed; available to October 1, 1955).

In the early use of automatic work handling for machine tools, it was customary for the manufacturer to purchase a standard machine and design a work-handling device that would meet his needs. Because no thought had been given to apply such a device when the machine was designed, it usually resulted in a very cumbersome and unreliable device.

Later single-unit machines were designed incorporating their own handling devices. Automation on this type of machine was very satisfactory from the standpoint of operation, but it required an operator to position the work on the receiving station and usually a helper to remove the work and push it along a conveyer to next machine in the line.

We are now in the stage where machines must be designed to operate as a fully automatic unit in an automatic factory. A machine tool now may be required to receive the work from the preceding machine, process the work through the necessary operations, free the work of chips, automatically gage, reject out-of-size work, stop machine, reset or insert sharpened tools, and deliver the work part to the succeeding machine in the line.

The machine tool has advanced from a comparatively simple machine, controlled by an operator, to a highly automatic machine that should perform its operation continuously at reliably and

with as little attention as an automatic watch.

This paper discusses the basic machine, feed and rapid transverse drives, electrical controls, hydraulic controls, and cutting tools.

The paper concludes that although great strides have been made in designing machine tools and accessories for automation, there are still unlimited possibilities for the future.

The most eminent single item that may affect future designs will be the increased application of electronic computers, digital converters, and various feedback systems to the controls of automation in all its phases such as the machine tool itself, work-handling, accumulation of gaging data, production output, programming, and the like.

Designing Dependability and Safety Into Transfer Machines, by J. H. Mansfield, Fellow ASME, Greenlee Brothers & Company, Rockford, Ill. 1954 ASME Annual Meeting paper No. **54—A-78** (multilithographed; available to October 1, 1955).

Transfer machines, because of their size, look complicated. They are semispecial machine tools connected by conveyers and interlocked electrically. The electric and hydraulic components are the same as used on standard machine tools, but greater in number.

This paper presents the possibilities inherent in the automatic handling and machining of parts. High-production multiple-spindle way drilling, reaming, and tapping machines have been available since 1918, and transfer machines for milling, drilling, boring, reaming, and tapping since 1935. Examples of modern production transfer machines and their operating features are described.

Lubrication Activity

An Analysis of Orifice-Compensated Hydrostatic Journal Bearings, by A. A. Raimondi, Assoc. Mem. ASME, and John Boyd, Mem. ASME, Westinghouse Research Laboratories, East Pittsburgh, Pa. 1954 ASME-ASLE Lubrication Conference paper No. **54—LUB-17** (multilithographed; available to Aug. 1, 1955).

Although such desirable traits as low starting friction, ability to carry load with no shaft rotation, and high load capacity attainable regardless of lubricant viscosity have made the compensated hydrostatic journal bearing attractive to the designer, its wider application has been limited to some extent by the lack of analytical and experimental data.

While some performance characteristics of a capillary-compensated hydrostatic journal bearing were presented by Shaw and Macks in their recent book, the characteristics of the orifice-compensated hydrostatic journal bearing have not as yet been evaluated. In the course of investigating this particular bearing, certain discrepancies between theory and test were encountered, which upon reassessment of the assumptions on which the theory was based indicated that the influence of circumferential flow could be appreciable. When the capillary-compensated bearing was tested and analyzed in the light of these findings, a similar situation was found to prevail. This paper presents a more complete analysis of the capillary-compensated bearing and supplements this analysis with test data.

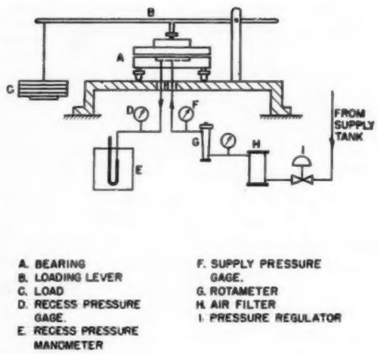
This analysis shows the essential parameters involved for predicting and analyzing the performance of both orifice and capillary-compensated hydrostatic journal bearings. The effect of accounting for circumferential flow is illustrated for both types of bearings and is shown to be appreciable when the pocket aspect ratio is relatively large. Orifice-compensated bearings are shown to exhibit a load capacity superior to the capillary-compensated bearing. The effect of the type of loading is discussed. A theoretical treatment of the influence of journal rotation is presented and indicates that load capacities based on static conditions may be conservative for rotating bearings.

A Preliminary Investigation of an Air-Lubricated Hydrostatic Thrust Bearing, by Lazar Licht, New York University, New York, N. Y., and D. D. Fuller, Mem. ASME, Columbia University, New York, N. Y., and The Franklin Institute Laboratories for Research and Development, Philadelphia, Pa. 1954 ASME-ASLE Lubrication Conference paper No. **54—LUB-18** (multilithographed; available to Aug. 1, 1955).

Because of the growing interest in the lubrication of bearings with air, this investigation of a simple hydrostatic thrust bearing was undertaken.

The bearing consisted of two circular plates, six in. in diam, and one inch thick, made of low-carbon steel. The lower plate had a circular recess two in. in diam. The depth of this recess could be varied by the introduction of filler plates. Both bearing plates were ground and lapped to a high degree of flatness.

Air was introduced to the 2-in-diam recess through a 0.0475-in-diam drilled hole which formed a short, parallel-element section of a convergent nozzle. Supply pressure to the nozzle could be regulated and held constant within the range of pressure from 5 psig to 55 psig. The air was filtered. Flow was measured by laboratory-type precision rotameters. The bearing could be loaded directly by means of dead weights or by a lever system. The air passed from the recess through an annular gap out to atmosphere. This gap was varied in thickness from 0.001 in. to 0.003 in. and measured by three dial indicators graduated to 0.0001 in. Air pressures were measured either by calibrated bourdon-tube gages or manometers.



Details of the test layout: *a*, Bearing; *b*, loading lever; *c*, load; *d*, recess pressure gage; *e*, recess pressure manometer; *f*, supply pressure gage; *g*, rotameter; *h*, air filter; and *i*, pressure regulator.

Equations are developed in this paper for load-carrying capacity, film thickness, pressure profile, and volume of air required for a typical thrust bearing. Conditions leading to stability of operation are also considered.

A comparison of theoretical and experimental values shows that within the limits of the test data, the performance characteristics of this bearing can be predicted with good accuracy.

Applied Mechanics

Two-Dimensional Flow About Half Bodies Between Parallel Walls, by J. P. Breslin, Gibbs and Cox, Inc., New York, N. Y. 1954 ASME Annual Meeting paper No. **54—A-3** (in type; to be published in the *Journal of Applied Mechanics*).

Two new families of blunt half bodies are derived from the combination of source distributions and a uniform stream. One is obtained from a source lamina placed normal to an infinitely broad free stream. The other family is obtained by using the same source distribution between parallel walls. Formulas for the half-body profiles and the velocity and pressure distributions are given.

Results of a calculation for selected values of the parameters are presented in graphical form. Applications of the formulas are made to give the pressure distributions on the profile and the walls. The influence of the walls on the pressure distribution and body shape is studied. An approximate relationship (obtained by neglecting the small change in body shape for large wall distances) is derived for the half-body size which may be placed between given walls with a prescribed error in the pressure at one point of the profile.

It is concluded that the influence of walls should be considered carefully in the design or use of two-dimensional facilities for study of flows which are of the half-body type.

Application of Saint Venant's Principle in Dynamical Problems, by B. A. Boley, Columbia University, New York, N. Y. 1954 ASME Annual Meeting paper No. 54—A-30 (in type; to be published in the *Journal of Applied Mechanics*).

The propagation of stresses in bars under time-dependent self-equilibrating end loads is discussed by means of a simple model.

It is found that high stresses are restricted to a short region near the end of the bar if the loads are applied comparatively slowly, but extend to longer portions if the loads are rapidly applied.

The Elastic-Plastic Stress Distribution Within a Wide Curved Bar Subjected to Pure Bending, by B. W. Shaffer, Assoc. Mem. ASME, and R. N. House, Jr., Assoc. Mem. ASME, New York University, New York, N. Y. 1954 ASME Annual Meeting paper No. 54—A-94 (in type; to be published in the *Journal of Applied Mechanics*).

Analytical expressions are obtained for the radial and circumferential stress distributions within a wide curved bar made of a perfectly plastic material when it is subjected to a uniformly distributed bending moment. The elastic stress distributions are based on the use of the Airy stress function, whereas the plastic stress distributions in this problem of plane strain are based on the use of the Tresca yield condition.

It is found that as the bending moment increases in the direction which tends to straighten the initially curved bar, an elastic-plastic boundary develops first around the concave surface. It meets a second boundary, which starts sometime later around the convex surface, when the bar is completely plastic. The elastic region within the bar decreases at a fairly uniform rate as the bending moment increases to within approximately 90 per cent of the fully plastic bending moment but then it degenerates very much more rapidly until it no longer exists when the bar is completely plastic. The position of the neutral surface is independent of the applied bending moment when the stress distribution is within the completely elastic and the completely plastic ranges. Within the elastic-plastic range, however, it moves away from, and then toward, the center of curvature as the bending moment increases.

Buckling of Continuous Columns, by H. C. Perkins, Mem. ASME, Cornell University, Ithaca, N. Y. 1954 ASME Annual Meeting paper No. 54—A-32 (in type; to be published in the *Journal of Applied Mechanics*).

This paper describes briefly an interesting procedure for setting up the characteristic equation of a continuous column, using the method of superposition.

Stress Distributions in Nonsymmetric Rotating Rays, by P. G. Hodge, Jr., Mem. ASME, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1954 ASME Annual Meeting paper No. 54—A-96 (in type; to be published in the *Journal of Applied Mechanics*).

The centrifugal forces acting upon a rotating ray will produce longitudinal stresses along the ray. If the ray is not symmetric, these stresses will result not only in a longitudinal force, but also in a bending moment.

A technique for finding the stress distribution in this case is developed and illustrated by means of simple examples. The limiting elastic speed and the maximum speed before large-scale plastic deformation commences are computed. An indication is given of how similar methods may be used to analyze a rotating disk with no plane of symmetry perpendicular to the axis.

A Refinement of the Theory of Buckling of Rings Under Uniform Pressure, by A. P. Boresi, University of Illinois, Urbana, Ill. 1954 ASME Annual Meeting paper No. 54—A-2 (in type; to be published in the *Journal of Applied Mechanics*).

A general variational theory of elastic stability that was originated by E. Trefftz is applied to the problem of buckling of rings of rectangular cross section subjected to uniform external pressure. The theory is believed to be more rigorous than previous treatments of the problem, since it avoids conventional assumptions of curved-beam theory, such as the assumptions that plane sections remain plane and that radial stresses vanish. The classical result of Levy is confirmed for a ring of infinitesimal thickness.

New results are obtained which show the effect of the finite thickness of a ring on the coefficients in the buckling formula.

Lateral Buckling of Asymmetrical Beams, by H. L. Langhaar, Mem. ASME, University of Illinois, Urbana, Ill. 1954 ASME Annual Meeting paper No. 54—A-99 (in type; to be published in the *Journal of Applied Mechanics*).

A simplified theory of lateral buckling of asymmetrical beams under the action of uniform bending moments and axial thrusts is developed.

Axially Symmetric Flexural Vibrations of a Circular Disk, by H. Deresiewicz, Assoc. Mem. ASME, and R. D. Mindlin, Mem. ASME, Columbia University, New York, N. Y. 1954 ASME Annual Meeting paper No. 54—A-15 (in type; to be published in the *Journal of Applied Mechanics*).

At high frequencies, the flexural vibrations of a plate are described very poorly by the classical (Lagrange) theory because of neglect of the influence of coupling with thickness-shear vibrations. The latter may be taken into account by inclusion of rotatory inertia and shear-deformation terms in the equations. The resulting frequency spectrum is given, in this paper, for the case of axially symmetric vibrations of a circular disk with free edges and is compared with the spectrum predicted by the classical theory.

The Effect of Elliptic Holes on the Bending of Thick Plates, by P. M. Naghdi, Assoc. Mem. ASME, University of Michigan, Ann Arbor, Mich. 1954 ASME Annual Meeting paper No. 54—A-26 (in type; to be published in the *Journal of Applied Mechanics*).

The effects on an elliptic hole on both plain bending and pure twist of an elastic plate are investigated by application of the recent theory for bending of plates due to E. Reissner, where the influence of shear deformation and transverse-normal stress is taken into account. The stress-concentration factors are given for both cases mentioned.

The solution, which is approximate in character, involves modified Mathieu

functions of the second kind. In limiting cases, the results reduce exactly to the solution of corresponding problems with circular hole, as well as to the predictions of the classical theory of plates.

Availability List of Unpublished ASME Papers

A NUMBER of papers and reports were presented at ASME Meetings which were not preprinted nor published. Manuscript copies of these papers are on file for reference purposes in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y. Photostatic copies of these unpublished papers may be secured from the Library at the rate of 40 cents per page. The following papers recently have been placed on file in the Engineering Societies Library:

1954 ASME Semi-Annual Meeting

How the Engineering Approach Is Solving Tough Safety Problems in Industry, (Panel Paper) Subtitle: Standards for Safer Material-Handling Slings Developed Through Co-Ordinated Engineering, by H. B. Duffus and S. W. Sandberg

How the Engineering Approach Is Solving Tough Safety Problems in Industry, (Panel Paper)—No subtitle—by E. L. Bishop

How the Engineering Approach Is Solving Tough Safety Problems in Industry, (Panel Paper)—No subtitle—by G. D. Cross

Swelling and Drying of Fuel O-Rings, by R. A. Clark and R. M. Kell

Impact Thermosetting Plastics With Responsibilities, by Paul E. Fina

Powder Metallurgy—Processes & Applications, by M. F. Judkins

Compounding Principles Involved in the Production of O-Rings, by D. S. Messenger

Characteristics of Heavy-Section Aluminum Alloys From Large Ingots, by R. T. Myer and W. A. Dean

Handling and Dustiness Characteristics of Fine Coal, by H. L. Washburn

Community Progress—A Challenge to the Engineer, by A. B. Van Buskirk

The Engineer and His Civic Duty, by R. R. Tucker

Experience With Turbojet-Engine Lubrication Systems, by J. L. Hatch and L. E. Goodding

Review of High-Speed Heating and Comparison With Heat Transfer Obtained in Conventional Furnaces, by J. W. Percy

High-Speed Heating of Steel For Plastic Deformation, by E. G. de Coriolis

1954 ASME Fall Meeting

Four Years of Natural Gas in Milwaukee Industry, by J. H. Mikula

Small Steam-Plant Design Considerations, by J. Breslove, Jr.

Developing the Sales Organization, by Paul C. Kreuch

Evolution of Centrifugal-Pump Type From a Specific-Speed Standpoint, by W. W. Weltmer

Can Your Company Survive Without New Products? by George H. Woodard

Conveyerizing a Multistory Building, by R. I. Anderson

Some Management Aspects of Industrial-Product Development, by A. A. Markson

Developments in Conveying Equipment, by B. G. Schneider

Recent Developments in Conveyer Belting, by D. R. Scheu

Market Research for the New Product, by B. E. Estes, Jr.

Hydroelectric Systems in Brazil, by C. L. Babb

1954 ASME Instruments & Regulators Division Conference

Value Analysis of Aircraft Instruments, by A. G. Woodside

The Value of Instrumentation to the Chemical Industry, by E. I. Thomas

1954 ASME Petroleum Mechanical Engineering Conference

Pressure-Weld Technique for Stub-Ending Drill Collars, by J. L. Dickmann

Field-Applied Linings for Corrosion Protection of Pressure Vessels in Petroleum Refineries, by S. J. Artese

1954 ASME Annual Meeting

Impact of Industrial Noise on the Economy, by N. S. Symons

Automation, by J. D. Rumsey

Design of Materials-Handling Equipment—The Load-O-Mat, by F. H. Field

Engineering Considerations in Plant-Revamp Work, by John M. Black

ASME Transactions for January, 1955

THE January, 1955, issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

Technical Papers

Design of Chimneys to Control Down-Wash of Gases, by R. H. Sherlock and E. J. Lesher. (53—A-80)

A Magnetic-Impulse Rapper System for Electrical Precipitators, by H. J. Hall and T. A. Pierson, 3rd. (53—A-131)

Performance of the Periphery Pump, by H. W. Iversen. (53—A-102)

Observations on Some Factors Affecting Timken Data for EP Lubricants, by A. J. DeArdo and E. M. Kipp. (53—A-39)

On the Solution of the Reynolds Equation for Slider-Bearing Lubrication—VIII, by A. Charnes, F. Osterle, and E. Saibel. (53—A-38)

Studies in Cold-Drawing, Part 1—Effect of Cold-Drawing on Steel, by H. Majors, Jr. (53—A-73)

Studies in Cold-Drawing, Part 2—Cold-Working 2S-O Aluminum, by H. Majors, Jr. (53—A-74)

The Effect of Dispersions on Creep Properties of Aluminum-Copper Alloys, by W. H. Giedt, O. D. Sherby, and J. E. Dorn. (53—A-78)

Machinability Research With J&L Tool Dynamometer on Titanium 150A, by Leif Fersing and D. N. Smith. (53—A-207)

Testing Large Steam Turbines With Weighing Tanks, by W. A. Pollock. (53—A-66)

Transient Gas-Flame Temperatures in a Spherical Bomb, by Y. M. Miao, T. W. Price, and J. H. Potter.

Comments on Papers

Including Letters From Readers on Miscellaneous Subjects

Shock Testing

Comment by D. E. Hudson[1]

Extensive experience of the author of this paper[2] and his many contributions to the field of shock testing and design enable him to present an authoritative picture of the present status of the subject and to suggest several promising directions for future investigations. The following comments are concerned mainly with just one of the important aspects of the problem—the usefulness of the response spectrum of a dynamic load.

One of the important features of the approach used by the author in considering the effects of shock loads on structures is the fact that all possible kinds of dynamic loads are included. In the past there has been some confusion regarding the differences between impact loads, shock loads, suddenly applied loads, vibration loads, transient loads, and so on. Since the author focuses his attention on the effect of the load on the structure rather than on characteristics of the load itself, he is led directly to the properties of the structure of most importance to the designer, no matter what kind of dynamic load is involved. The response spectrum of a force, which physically represents the behavior of a structure under the action of the force, is a logical expression of this shift in emphasis from the load itself to the effect of the load on a structure. The response spectrum has the same importance for general dynamic-loading problems that the familiar resonance curve has for the steady-state forced-vibration problem. The resonance curve, in fact, is just the response spectrum for one particular type of load, the continuous sine wave.

Difficulty in Applying Technique

There is one basic difficulty in the application of the response-spectrum technique which perhaps deserves an additional comment. Many machine structures are so complicated that the single-degree-of-freedom approximation, which assumes a single mass and spring as a model of the structure, does not exactly apply. The usual practice would be to consider the complex structure as the sum of several simple systems, and to suppose that the behavior of the complete structure could be obtained by a superposition of the behavior of the individual simple systems. From a knowledge of the response spectrum alone, this superposition can be only an approximation, because of the coupling between the systems which has been mentioned by the author. For very complicated structures this difficulty can introduce inaccuracies into the total response calculations which can be as high as 30 to 40 per cent.

Additional theoretical work on the response of complex systems, and increased studies of the correlation of such theory with test work, should reduce such inaccuracies to the extent that even for very complicated structures a 5 to 10 per cent estimate of the dynamic responses should be possible. These difficulties with the more complex structures, however, should not obscure the very great usefulness of the response-spectrum concept for simple systems, among which is a very large number of actual machine parts and structures.

The importance of rational shock-test requirements in military specifications can hardly be overestimated. In the recent past some specified shock tests have not only been very difficult for the contractor to make, but they have involved test conditions that were quite unrelated to the contemplated service conditions. It is comforting to hear that this condition is now much improved, and we may hope that an increased awareness of the shock-loading problem, which will be promoted by this paper, will lead to still further advances.

Author's Closure

The author is encouraged by Professor Hudson's support of the viewpoint set forth in the paper. Professor Hudson's own contributions in a closely related field, viz., earthquake analysis, are important in emphasizing that the effect of a shock motion upon a structure is of greater significance than a description of the shock motion. It is hoped that an increasing realization of this viewpoint will continue to promote a more rational philosophy concerning shock testing and designing to withstand shock.

Professor Hudson's comments regarding complex structures are well taken. A spectrum of the type discussed in the paper is useful only if the structure under consideration can be represented as a simple system. It is evident that many structures are difficult to idealize in this manner. The extension of the spectrum method to coupled systems of multidegrees of freedom offers very interesting possibilities, and it is hoped that future research will proceed in this direction.

Charles E. Crede.[3]

Titanium Technology

Comment by Lee S. Busch[4]

In its short industrial life, titanium has recorded many notable achievements and the authors and their company have played a highly significant and successful role in the growth of the titanium industry. Their paper[5] is a good summary of the progress made to date. However, there are some phases of the record, as submitted by the authors, which are controversial, and the remarks which follow attempt to present another viewpoint on the subject.

The system of nomenclature which the authors suggest can lead to oversimplification of complicated alloy systems. The writer feels that it is yet too early to attempt to designate alloys by the phases which can exist in titanium alloys. Their proposed system, for instance, says nothing about the compounds which can form in alloys, and

[1] Associate Professor of Mechanical Engineering, California Institute of Technology, Pasadena, Calif. Mem. ASME.

[2] "The Role of Shock-Testing Machines in Design," by C. E. Crede, Mechanical Engineering, vol. 76, July, 1954, pp. 564–567.

[3] Chief Engineer, The Barry Corporation, Watertown, Mass. Mem. ASME.

[4] Director of Research, Mallory-Sharon Titanium Corporation, Niles, Ohio.

[5] "Titanium Technology in Mid-1954," by H. T. Clark, J. P. Catlin, and W. E. Gregg, Mechanical Engineering, vol. 76, September, 1954, pp. 716–720.

which can cause loss of ductility upon exposure to temperatures as low as 600 F. Strength levels thought to be reasonable two short years ago have had to be revised downward because the purity of the raw materials has improved. A new alloy containing five elements is presently being considered for production. In this particular alloy, strength levels can predictably be varied from 120,000 to 180,000 psi yield strength. What figure would one use in this designation? A condition digit or letter would necessarily be required. If one used the designation, it could read as follows: C 180 MFCMV (heat-treated).

In the brief portion of the paper which treats of melting, the authors do not mention the importance of this process in production of homogeneous ingots. The double-melting process using a consumable electrode is presently in use by two producers to insure ingot homogeneity.

The authors present a curve, Fig. 5, in which they indicate that the creep rate of titanium at 400 to 700 F is higher than the yield strength. The usable rates of creep, as measured by total deformation at a particular temperature and stress, are much lower. Although the creep rates of 1 to 10 per cent shown in the curves may find use in airframe applications, engine designers speak of creep in terms of tenths of one per cent. A new alloy containing 6 per cent Al, 4 per cent V, presently regarded as excellent in this regard, has a limiting temperature of 750 F for 0.2 per cent total deformation at 50,000 psi in 300 hr. This is about 50 per cent of the yield strength at 750 F. At 0.2 per cent total deformation, which the writer feels is a more realistic figure, the allowable stress in this temperature range for unalloyed titanium would not exceed 50 per cent of the yield strength.

The authors also discuss the strain-rate sensitivity of titanium. Recent experiments in the research laboratories of the writer's company indicate that this strain-rate sensitivity is a function of chemistry, notably the O_2, N_2, and H_2 content and particularly hydrogen. Titanium with low O_2, N_2, and H_2 content is no more strain-rate sensitive than other metals.

pressure, and idle strokes, and included the minimum data necessary for the calculation of hydraulic-system requirements.

Determining Press Capabilties

The final determination of the productive capabilities of each press must be established on the basis of actual operating experience after assessing the effect of the tremendous inertia of the moving parts of the press, the pipe-line and valve losses, the valve action, and the other indeterminate quantities in the press unit. These must be tempered with the production considerations of the efficiency of handling the product, the quantities in each production lot, the availability of dies, and the manifold factors influencing percentage utilization of the equipment.

It is highly probable in some instances that accumulator and pump capacities may have to be supplemented at a later date in order that the Air Force facilities be in readiness to fulfill the maximum production in cases of emergency. Such a reappraisal in the future is the inevitable result of the care and consideration that have been employed in the expenditure of public funds for the heavy-press program.

Accumulators for Heavy Presses

Comment by R. W. Andrews, Jr.[6]

The data presented in this excellent paper[7] provide some interesting and thought-provoking facts. For purposes of comparison the writer has tabulated the information and has added some information from a 3000-ton R. D. Wood die-forging press unit and from the Alcoa installation of the Air Force's 15,000-ton Schloemann forging press (Table 1).

these are not ordinary presses but rathe are designed for modern closed-die metalworking requirements. If the valves and pipe lines are designed for conservative velocities we may well achieve short period rates with theoretical horsepowers several times as great as the values tabulated. This demonstrates clearly the importance of an accumulator as an ever-ready reservoir of potential energy for highly rated heavy-duty presses.

The connected horsepower is an index of estimated average power requirements.

The horsepower ratios considered with

Table 1 Comparison of Various Heavy Presses

Press	Max speed at pressure, ips	HP at max press	Connected HP	HP ratio	Total vol. accumulator, gal
3000-T Wood	3	2727	600	4.5	5100
15000-T Schloemann	3	13630	2400	5.7	10200
35000-T United	$2^1/_2$	26515	3500	7.6	15000
35000-T Loewy	$2^1/_2$	26515	6000	4.4	11900
50000-T Loewy	$2^1/_2$	37879	7500	5.1	20825
50000-T Mesta	$2^1/_2$	37879	3000	12.5	14000
12000-T Ext-Loewy			3000		23800
14000-T Ext-Schloemann			2800		17952

It can be seen from the horsepower required at maximum rated speed that the respective accumulator volumes are a relative measure of the optimism or conservatism employed in estimating the operating cycle and the productive rates for each press.

The specifications submitted by the Air Force to each builder contained stipulations for maximum speeds, of

[6] Division Head, Central Mechanical Engineering Department, Aluminum Company of America, Pittsburgh, Pa. Mem. ASME.

[7] "Hydraulic Accumulators for Heavy-Press Operation," by A. F. Welsh, Mechanical Engineering, vol. 76, July, 1954, pp. 571–574, 581.

Comment by F. J. Gleve[8]

The author is to be congratulated for his excellent and comprehensive paper on accumulator stations. Our company is employing all three types of accumulators.

The weight-type accumulator is confined to short-stroke machinery, such as roll balance on rolling mills. In this design the ballast-shell diameter has to be properly proportioned to the length to eliminate unequal distribution of ballast, which would increase the friction.

The intensifier-type accumulators are employed mostly on steam-hydraulic presses where steam is of 100 to 200 psi pressure on the large piston, and hydraulic outputs of 5000 to 7500 psi are reached. Some smaller sizes of the intensifier-type accumulator are used for servocontrols to supplement the oil pumps and to give a small storage capacity.

On the air-loaded-type accumulator, the author mentions the vortex created by the withdrawal of water from the water bottle during the course of operation. We believe that in solving the

[8] Assistant Chief Engineer, United Engineering and Foundry Company, Pittsburgh, Pa.

vortex problem it is important to have as low a water-level drop rate as possible and still be safe. We believe that there exists a relationship between the fall of the water level in the bottle and the water velocity at the bottom outlet. We should like to invite discussion on this subject. Furthermore, we are interested in the best location of the accumulator safety valve. Our practice is to place the accumulator safety valve next to the accumulator and the shutoff valve next to the safety valve. We feel that the safety valve will work only in case of emergency and is of such design that packing repairs can be made while this valve is closed. The shutoff valve will be used frequently, as, for instance, when closing down the installation or for major repairs. When repacking the shutoff valve, the safety valve will be closed. Also, we are interested in a good protective coating, which does not readily peel off, for the inside of the vessel. We have mostly specified zinc-chromate coating. We are interested in knowing whether asphaltic-type paints or similar coatings have been used.

Comment by W. Ehlers[9]

THIS paper gives an excellent description of the different types of accumulators which have been used in the past hundred years. The writer's company has built hundreds of weighted-type accumulators, especially those of the moving-ram or moving-cylinder type. The ballast tanks for these accumulators were filled with different materials, such as sand, stone, cement, cast iron, pig iron, or steel borings. But in recent years these accumulators have been replaced by the type which are discussed in the paper, namely, the air-bottle type.

The writer will confine his comments to some details such as the size and types of air compressors to be used, especially with high-pressure air-bottle units.

Working Pressure of Air Bottles

A time of 100 to 150 hr seems to have been accepted as more or less standard for bringing the pressure in the accumulator bottles from atmospheric to the minimum normal working pressure. The writer would recommend water-cooled compressors of such a size that the pressure build-up time will not exceed 100 hr. Increasing the size of compressor will of course increase the initial cost of the accumulator unit but it really pays off if any down time should be experienced due to loss of air through valves or leaky connections. On the 25,000-ton Air Force press which we built, a compressor of 40 cu ft capacity was specified, and the build-up time is 116 hr. On an 11,000-ton forging press which we built we used a 39-cfm unit and the build-up time was 152 hr. For both of these units the pressure build-up time was specified by the customer.

Pumps of the horizontal and vertical reciprocating type with suction unloaders or by-pass valves have been used by our company. Centrifugal pumps also have been used for charging high-pressure accumulator bottles.

Most accumulator units are equipped with air-relief valves. The setting of these is equal to the maximum design pressure stamped on the bottle. Units equipped with rupture disks have to be built up for a higher design pressure in bottles—as the setting of the rupture disks must be 50 per cent above the maximum working pressure. This also will result in a higher initial cost of the air and water bottles.

As for controls for these high-pressure accumulators, we recommend that level controls instead of pressure controls be used for cutting the pumps in and out and also for closing the low-level shutoff valve. We do, however, usually furnish a high-pressure switch which will stop the pumps in case the pressure should exceed the maximum allowable working pressure before the top-level control can function. A minimum-pressure switch also is being used for closing the low-level shutoff valve in case the low-level control should fail.

[9] Chief Engineer, Hydraulic Press and Power Tool Engineering Department, Baldwin-Lima-Hamilton Corporation, Eddystone, Pa.

Re-Evaluating Manufacturing Processes

Comment by Ray D. Allison[10]

IT IS agreed that the re-evaluation from receiving to shipping of an entire line may produce major savings in manufacturing costs.[11] However, in no case could it be recommended that individual operations not be scrutinized or examined continually.

There are two reasons for this: (*a*) In the case of smaller-plant operations it may be impossible to carry on these complete re-evaluations at definite intervals. (*b*) After a complete re-evaluation is made, it is necessary to continue to examine individual operations to remove any bugs and still further to reduce costs as the over-all complete plan in itself will not produce the desired final results.

Individual operations should be under constant scrutiny by the heads of all departments and every suggested change or improvement, regardless of how small it may be, should be transmitted immediately by means of a proper form to the department that may effect the change or improvement.

A periodic re-evaluation of manufacturing processes is certainly recommended on any part or product that is produced in any repeat quantities. In addition to this type of part or product, however, there are components or complete machines that pass through a complete production process only once. Here it is highly essential that production personnel use every available means to examine each individual operation as it passes through the production process so that every benefit possible may be obtained during its only run.

Concerning the plan for re-evaluation, the subject has been covered very well by the author.

Organization for Re-Evaluation

The organization for re-evaluation may be drawn from an outside consulting firm or a separate company department as suggested. However, in either case it is highly essential that the group be fully acquainted with the particular type of work being investigated and thoroughly familiar with the facilities on hand to accomplish the work. It is also important in the case of the outside consulting firm that its personnel be well-acquainted and grounded in top-management's policies and that it make recommendations in line with these policies, especially the best use possible of facilities at hand.

The re-evaluation follow-up, if carried out properly, is the secret of success in any plan of this type. In connection with the follow-up, we believe it to be absolutely necessary that every member of the production force be vitally interested and concerned in making the improvements. In this particular instance, it is our belief that the foremen also should be expected to carry out new methods and report back very quickly any further improvements that can be made or any troubles that are encountered at the time. Basically, the foreman should not be burdened with excessive paper work in his department but should devote a great proportion of his time in

[10] Vice-President, The J. H. Day Company, Incorporated, Cincinnati, Ohio.

[11] "A Periodic Re-Evaluation of Manufacturing Processes," by W. H. Friedlander, MECHANICAL ENGINEERING, vol. 76, August, 1954, pp. 649–652.

studying methods and assuring the company of a proper follow-up of new ideas that are presented to his department.

Incentives

For such a plan to be effective it is also highly desirable that an incentive be provided for the operator, to assure a desire on his part to make the best use possible of new tools, methods, and ideas that are presented for his particular operations. This incentive may be monetary or created through high-grade human relations, or both. The incentive provided by good employer-employee relations is created, first of all, through education and is based on the ability of management, especially the foremen, being able to intelligently and completely present the facts and the problems so that the operator will have a complete understanding of the objective and the over-all benefits from good results.

The paper, as presented, outlines a very workable plan for a majority of companies to effect considerable manufacturing cost reductions, and in whole presents a complete program for accomplishing these results.

Author's Closure

The writer wishes to thank Mr. Allison for his constructive comments. It is true, of course, that the re-evaluation of manufacturing processes must be continuous and should not necessarily be limited to definite periods. At the same time, the writer has found that in most plants the work load is such that production engineers seldom have time to go back over established lines which do not cause difficulties. The establishment of a periodic cost-reduction study assures that these production lines also receive attention.

Incentives can be very useful. Monetary awards for improved methods, given in conjunction with an organized plan for re-evaluation, can be helpful in reducing costs.

W. H. Friedlander.[12]

[12] Partner, Metcut Research Associates, Cincinnati, Ohio.

Reviews of Books

And Notes on Books Received in Engineering Societies Library

Ships, Machinery, and Mossbacks

Ships, Machinery, and Mossbacks. By Harold G. Bowen. Princeton University Press, Princeton, N. J., 1954. Cloth, $5^1/_2 \times 8^1/_2$ in., appendixes, index, vii and 397 pp., $6.

Reviewed by William F. Durand[1]

The author of this book in six most absorbing chapters tells the story of his 46 years in active U. S. Naval Service—a story unique in the wide scope of this service, from 25 years of normal Naval duty, afloat, and ashore, to a second most important phase, covering the direction of Naval research, the seizure and operation of industrial plants, engaged on work on Naval contracts and derelict in some degree and manner in connection with such work, and ending with a final period as a director of Naval research.

Following high school in Providence, R. I., he won, on competitive examination, an appointment to the U. S. Naval Academy at Annapolis, Md., in 1901, and was graduated in 1905. Then followed a wide variety of assignments on shipboard and on shore which, to an increasing degree, swung to the engineering phases of Naval service and which culminated in services of an engineering and scientific character rather than to so-called deck duty.

[1] Past-President and Hon. Mem. ASME.

Perhaps the most interesting chapter of the six is the second, in which is described in detail his long and finally effective struggle against conservatism, indifference, doubt, and even opposition in higher levels of the Naval service, afloat and ashore, to establish, for the Navy, the policy of paralleling, at a safe distance the practice in land power-plant engineering in the use of advancing pressures and temperatures of steam for the generation of power for Naval propulsion. The final result of a definite recognition of this as a fixed Naval policy required firm conviction of the correctness of his position, tenacity of purpose, boldness where required, combined with diplomacy, wisdom, and good judgment, all of which the Admiral showed in marked degree. The story in this chapter is told with entire frankness and with a degree of detail which marks it as an authoritative record of this important phase of Naval engineering, extending over some ten years of time, roughly 1930 to 1940.

Of scarcely less interest, though much shorter, is chapter 3 describing the change from steam to diesel power for destroyers, and from gasoline to diesel for small-boat drive. Here, as for the increase in steam pressure and temperature for ship drive, was encountered the same hesitation and resistance to change in the higher levels of Naval personnel but, in due time, Admiral Bowen's persistence and diplomacy won out and the new policy became standard, only now, possibly facing displacement by the new atomic drive.

The Admiral's term as Engineer-in-Chief of the Navy expired in 1939 and he was, following retirement as such, appointed in charge of the Naval Research Laboratory. Here he was placed in charge of research in many widely scattered fields ranging over the domains of engineering, physics, and chemistry, with especial emphasis on radio and radar. In particular, this chapter gives in detail the part played by radar in several of the sea battles in the Pacific in the war with Japan.

In 1940 Admiral Bowen became interested and involved in the development of atomic energy and was identified with some of the earlier steps in this all-important field of research. This phase of his work is described in his characteristic direct narrative style.

Chapter 5 is the longest in the book and in its 140 pages Admiral Bowen describes a most amazing and varied experience, quite out of the normal path of Naval duty. During this period, usually

under an executive order from the President, he seized the plant and plant facilities of some industrial organization which was failing to carry out the terms of a government contract for material or munitions of war, and operated the plant until the faulty conditions were corrected and brought to a normal and satisfactory rate.

Altogether there were over 100 of such seizures and at several periods two or more plants at the same time. Obviously to meet these conditions, agents of the Admiral would be required for the immediate and personal direction of the affairs of the plant, but under the general plans and detail laid down by Admiral Bowen.

This experience called, in some cases, for the handling of strikes or other labor troubles and, in others, for the correction of plant conditions or management affecting production. At some period Admiral Bowen was thus in operative charge of several plants in various parts of the country at the same time. In some cases he was authorized by the Executive order to use U. S. troops if necessary to carry out the terms and conditions of the order.

This wide and varied experience called for boldness and firmness of character, combined with skill, diplomacy, and a calm persuasive manner, in order to successfully meet the widely varying human factors entering into this assignment.

The narrative in this chapter is plain, direct, and straightforward and gives a vivid and clear picture of this interesting and most unusual task for an officer of the Navy.

The close of the war brought to a period this term of service and Admiral Bowen was assigned by the Secretary of the Navy in October of 1944 to duty as the head of an office of Naval Patents and Inventions.

The problem of patents in the Navy had long been troublesome and needful of review and correction. Admiral Bowen had already had some contact with these conditions and problems and attacked them with his normal aggressive boldness and vigor. Needed changes were introduced; the taking out of patents by Navy personnel was much facilitated and order was introduced into the whole field of patents in relation to the Navy. About a year later, in May of 1945, the Secretary of the Navy issued a directive establishing in his office an Office of Research and Invention, and appointing Admiral Bowen as the head of this office. This directive provided for the incorporation, under the Chief of Research and Inventions, of the Office of Research and Development (from the Office of the Secretary), the Naval Research Laboratory (from the Bureau of Ships), and the Division of Special Devices (from the Bureau of Aeronautics).

This assignment brought Admiral Bowen into immediate relation with a wide variety of projects of a scientific and research character, among them the Manhattan Project concerned with the development of the first atomic bomb.

In June of 1947 Admiral Bowen reached the statutory age of retirement from active service in the Navy and thus was brought to a period this long and active lifework, covering 46 years.

A notable feature of the book is the generous and warm complimentary references made to assistants and co-workers. This feature brings to light many names which otherwise might have remained buried in official records.

The book as a whole is written in a plain narrative style, boldly and with free criticism of conservatism and resistance to his convictions of what he was firmly convinced of as needful for the continued advance in the effectiveness of our Naval materiel.

It gives a plain and straightforward statement of the life service of a fearless, bold, and forceful administrator over a period of supreme importance in the improvement of Naval materiel, and brings the story to the first stages of what may be the next great step forward, to atomic power for Naval propulsion.

Books Received in Library...

ASTM Standards on Coal and Coke. American Society for Testing Materials, Philadelphia, Pa., 1954. 155 p., 9 × 6 in., paper. $2.25. Twenty-seven methods of test, definitions, and specifications for coal and coke, and the standard specification for the classification of coal according to rank and grades are included. Appendixes give proposed methods of tests in draft form.

ASTM Standards on Textile Materials. American Society for Testing Materials, Philadelphia, Pa., 1954. 696 p., 9 × 6 in., paper. $5.50. These 111 standards cover asbestos, bast and leaf fibers, cotton, glass textiles, etc., and general fibers, fabrics, yarns, threads, and cordage. Information is included on identification, analysis, resistance to insects, testing machines, and other subjects. Twenty-five of the test methods recorded in the earlier edition have been revised and seven of the standards are new.

America's Resources of Specialized Talent. The Report of the Commission on Human Resources and Advanced Training. Prepared by Dael Wolfle, director. Harper Brothers, New York, N. Y., 1954. 332 p., 8¼ × 5¾ in., bound. $4. Presents results of a study of the characteristics of extensively and formally educated specialists, such as those in economics, agriculture, management, physics, and engineering. The three main problems considered are supply and occupational distribution, present and future demands, and the potential supply. A chapter embodying suggestions for improving utilization of the portion of the population able to benefit by further training is included.

Library Services

Engineering Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

Behavior of Metals Under Impulsive Loads. By John S. Rinehart and John Pearson. American Society for Metals, Cleveland, Ohio, 1954. 256 p., 9¼ × 6 in., bound. $5.50. Using a broad and general approach in order to furnish the physicist and engineer with a background for further studies, this book discusses the character of impulsive loading, conditions under which such loading develops, and the main phenomena involved when materials are subjected to rapidly applied loads of short duration. The book includes treatment of loads and forces generated by impacts and explosions, and of fundamental aspects of failure under impulsive loads.

Component Design. (Handbook of Aeronautics, No. 2) Published under the authority of the Council of the Royal Aeronautical Society. Sir Isaac Pitman & Sons, Ltd., London, England (available in U. S. from Pitman Publishing Corporation, New York, N. Y.), fourth edition, 1954. 207 p., 10 × 6¼ in., bound. $7.50. This volume, like others in the series, has been prepared by various authorities for the use of aeronautical engineers, technicians, draftsmen, and students. The eight parts of the book cover structures, landing gear, control systems, air-conditioning and pressurization equipment, power-actuating systems, riveting, weight estimation and control, and fuel systems. Considerable explanatory material accompanies the formulas and methods included.

Contributions to the Solution of Systems of Linear Equations and the Determination of Eigenvalues. (Applied Mathematics Series, No. 39.) Edited by Olga Taussky. National Bureau of Standards (available from Superintendent of Documents, G.P.O., Washington, D. C.), 1954. 139 p., 10½ × 8 in., bound. $2. Contains seven papers dealing mainly with various aspects of the solution of simultaneous equations, including practical methods with worked examples, a study of iterative procedures, manual-computation methods, experiments with punched-cards equipment, and high-speed computations. Two of the papers deal with the rank of a matrix and location of its eigenvalues.

Deterioration of Materials. Causes and Preventive Techniques. Edited by Glenn A. Greathouse and Carl J. Wessel. Reinhold

Publishing Corporation, New York, N. Y., 1954. 835 p., $9^1/_4 \times 6^1/_4$ in., bound. $12. Basic principles involved in the preservation of materials are discussed and the most effective practical preventive measures are summarized. The first section covers causes of deterioration and the nature of deterioration processes. The next two sections discuss prevention for broad classes of specific materials—metals, wood, paper, textiles, plastics, paints, etc.—and for assembled units—electrical, electronic, and photographic equipment, and optical instruments. References are cited after each chapter.

Fatigue. By Thomas J. Dolan, B. J. Lazan, and Oscar J. Horger. American Society for Metals, Cleveland, Ohio, 1954. 121 p., $9^1/_4 \times 6^1/_8$ in., bound. $3. The first of the three lectures included is an examination of the basic nature of fatigue damage in metals. Discussed briefly are progressive fracture and the micromechanisms of the phenomenon; the reasons why metals are weak in fatigue; phenomenological evidence and the statistical nature of fatigue damage; and design considerations. The subjects of the other lectures are failure under vibration conditions, and fatigue characteristics of large sections, i.e., any component of a sectional depth exceeding a few inches. References are listed after each lecture, and there is a combined index.

Gas Dynamics of Thin Bodies. By F. I. Frankle and E. A. Karpovich. Translated from the Russian by M. D. Friedman. Interscience Publishers, Inc., New York, N. Y., 1953. 175 p., $9^1/_4 \times 6^1/_4$ in., bound. $5.75. This translation was made as an aid to aerodynamicists and engineers studying linearized problems of compressible-flow theory. It consists of five chapters covering formulation of the problem, with a method of solving the differential equation; compressible flow around bodies of rotation; wings of infinite span in steady motion; unsteady flow and its application to supersonic propellors; and conical flow and its generalization.

General Theory of High Speed Aerodynamics. (High Speed Aerodynamics and Jet Propulsion, volume 6.) Edited by W. R. Sears. Princeton University Press, Princeton, N. J., 1954. 758 p., $9^1/_2 \times 6^1/_4$ in., bound. $15. A review of present knowledge of the subject. It includes a largely nonmathematical summary of major features, recent developments, and unsolved problems in subsonic, transonic, supersonic, and hypersonic flows by Theodore von Kármán. Other sections cover flow problems of the hyperbolic type, linearized supersonic theory (the largest section of the volume), the method of characteristics applied to flows with shock waves, and related subjects. References are cited after some chapters.

Instrumental Analysis. By John H. Harley and Stephen E. Wiberley. John Wiley & Sons, Inc., New York, N. Y., 1954. 440 p., $9^1/_4 \times 6$ in., bound. $6.50. This introductory textbook for senior and graduate chemistry students emphasizes the usefulness of various types of instruments and describes some of the commercial models presently available—spectrophotometers, colorimeters, fluorimeter, electropodes, etc. For each method there is discussion of theory, examination of components of the instruments involved, and review of typical procedures and applications. Selected references are included and laboratory exercises are given in the last chapter.

Inventions and Their Protection. By George V. Woodling. Matthew Bender & Company, Inc., Albany, N. Y., second edition, 1954. 495 p., $9^1/_4 \times 5^1/_4$ in., bound. $10. This book is intended as an aid to executive engineers and designers in the protection and commercial development of inventions. Nontechnical language is used in discussing patent ownership, filing applications, drafting claims, selecting and registering trade-marks, and related subjects. This revision includes additional problems, new legal citations, and changes made to bring the text into conformity with the Patent Codification Act of 1953.

Light Metals Handbook. By George A. Pagonis. D. Van Nostrand Co. Inc., New York, N. Y., 1954. 199 p., 185 p., $9^1/_4 \times 6$ in., bound. $8.50, 2 vol. net. Included for various classes of aluminum and magnesium-base alloys are data on mechanical properties at room, low, and elevated temperatures; physical properties; choice of alloys, casting; formability; heat-treatment; corrosion; machinability; joining methods; and detailed properties of individual compositions. Volume one presents the text; volume two, tables.

Mechanical Refresher for Professional Engineers License. By John D. Constance, 625 Hudson Terrace, Cliffside Park, N. J., first edition, 1954. Various pagings, $8^3/_8 \times 10^7/_8$ in., paper. $3. Another in the well-known series of reference manuals compiled to aid license candidates in preparing for examinations. It offers a summary of essential theory and numerous problems in the fields covered in Part 3 of the New York State Professional Engineering Examination, comparable to junior and senior examinations in other states.

Non-Circular Cylindrical Gears. (Acta Polytechnica, no. 135.) By Uno Olsson. Royal Swedish Academy of Engineering Sciences, Stockholm, Sweden, 1953. 216 p., $9^3/_4 \times 7$ in., bound. 18 Sw.Kr. A detailed development of the theory for the design and construction of these elements, and directions, likewise detailed, for their production in ordinary machine tools. The main purpose is to present a method by which it is possible to design, with any desired degree of accuracy, cylindrical-gear trains with noncircular wheels of any shape. Appendixes give tables prepared in the course of the investigation, e.g., those giving the arc length of the hyperbola and of the hyperbolic sign curve.

Packaging Engineering. By Louis C. Barail. Reinhold Publishing Corporation, New York, N. Y., 1954. 407 p., $9^1/_4 \times 6^1/_4$ in., bound. $9.50. A detailed discussion of materials and procedures used in industrial packaging. Special problems such as prevention of corrosion, protection against mildew, insects, etc., are dealt with and there are chapters on types of containers, package design, and packaging machinery. Packaging for export and for the armed forces and the drug and cosmetic industries are separately treated. A bibliography and list of government specifications are included.

Physical Measurements in Gas Dynamics and Combustion. (High-Speed Aerodynamics and Jet Propulsion, vol. 9.) Edited by R. W. Ladenburg and others. Princeton University Press, Princeton, N. J., 1954. 578 p., $9^1/_2 \times 6^1/_4$ in., bound. $12.50. The first part of this volume records a wide range of techniques for measuring density, pressure, velocity, and temperature in gaseous systems—interferometry, spectral absorption, ions as tracers, shielded thermocouples, and others. Part 2 reviews latest methods and tools used to measure flames and in the study of combustion processes. It also contains sections on flame photography, measurement of burning velocity, and mass spectroscopy. References are listed after each chapter.

Proceedings of the Symposium on Operations Research in Business and Industry. Sponsored by Midwest Research Institute, Kansas City, Mo., 1954. 185 p., $11 \times 8^1/_2$ in., paper. $5. Eleven papers, the first on the nature of operations research and its background, the remainder mainly on applications to management problems—office procedures, marketing, traffic, and transportation, etc. One of the papers discusses scheduling batched operations in petroleum-products pipe lines.

Profiting From Industrial Standardization. By Benjamin Melnitsky. Conover-Mast Publications, Inc., New York, N. Y., 1953. 381 p., $9^1/_4 \times 6^1/_4$ in., bound. $5.50. This book, of interest mainly to management engineers and executives, shows how to develop, distribute, and use industrial standards. Based largely on current American practice and illustrated by case histories, the book covers sources of industry, national, and government standards; organization of a standards department; development and application of company standards; classification; part numbering; design and purchasing standards; and related subjects.

Quantum Mechanics. By F. Mandl. Academic Press Inc., New York, N. Y., 1954. 233 p., $10 \times 6^1/_2$ in., bound. $5.80. Written as an introduction to the subject, this work presupposes a knowledge of classical physics, calculus, vector analysis, and the qualitative concepts of quantum theory, such as the wave nature of matter. The first five chapters cover underlying mathematical methods, wave-mechanical concepts, examples of energy eigenfunctions, general principles of quantum mechanics, and matrix mechanics. The last four chapters illustrate the use of the theory in solving specific problems involved in systems of many particles, perturbation theory, scattering, and group theory.

Report on the Elevated-Temperature Properties of Selected Super-Strength Alloys. (Special Technical Publication No. 160.) American Society for Testing Materials, Philadelphia, Pa., 1954. 208 p., $11 \times 8^1/_4$ in., paper. $4.75. This report is primarily a graphical summary of strength data for thirteen alloys. Summary curves are included for tensile strength; 0.2 per cent offset yield strength; per cent elongation and reduction of area; and stresses for rupture and creep rates. Chemical composition, and recommended heat-treatments and processing are given for each alloy. An appendix contains very short-time rupture data for some of the alloys, and chemical compositions for about 100 superstrength alloys.

Selection of Graphs for Use in Calculations of Compressible Air Flow. Prepared on behalf of the Aeronautical Research Council by the Compressible Tables Panel, L. Rosenhead (chairman). Oxford University Press, New York, N. Y., 1954. 115 p., $15^3/_8 \times 11^5/_8$ in., bound. $13.45. This volume, a companion to "Compressible Air Flow: Tables" (1952), was prepared to make available to engineers graphs of some mathematical functions which occur in the theory of the steady flow of air in which the effect of compressibility is taken into account. Graphs are grouped in the following sections: Isentropic Flow; Normal Shocks; Oblique Shocks; Conical Flow; and Reynolds numbers. Basic equations and explanations of the use of graphs are included.

Shell Molding and Shell Mold Castings. By T. C. Du Mond. Reinhold Publishing Corporation, New York, N. Y., 1954. 128 p., $6^3/_4 \times 4^1/_4$ in., bound. $2. A concise survey of how the process works and the advantages to be obtained from its use, made to enable the potential user to evaluate the method and to determine where such castings can best be used. Consideration is given to cost designing, comparison with other processes, equipment, materials, and applications.

Strength of Materials. By Arthur Morley. Longmans, Green and Company, New York, N. Y., eleventh edition, 1954. 532 p., $8^3/_4 \times 5^3/_4$ in., bound. $4.50. Revisions in this edition of a standard British text for engineering students include the reworking of material on fatigue, creep, criteria of elastic strength, and metallurgical developments of ferrous metals. The last three chapters of the previous editions have been omitted.

Symposium on Diesel Fuels. (Special technical Publication, no. 167). American Society for Testing Materials, Philadelphia, Pa., 1954. 50 p., 9 × 6 in., paper. $1.50. Eight of the nine papers included are discussions of problems of supply and demand and of procurement and use. Specifically, they deal with storage, distribution, furnace oils as fuel, and with various aspects of the use of diesel fuels in contractors' equipment, interstate coaches, railroads, and in marine operations. The ninth paper reviews diesel-fuel specification requirements.

Symposium on Fatigue. Symposium on Human Factors in Equipment Design. (Ergonomics Research Society Proceedings, vols. 1 and 2.) Edited by W. F. Floyd and A. T. Welford. H. K. Lewis & Company, Ltd., London (distributed in U. S. by John de Graff, Inc., New York, N. Y.), 1953, 1954. 196 p., 132 p., $9^3/_8 \times 6^3/_8$ in., bound. $4 each. The papers in these symposiums present the viewpoints of anatomists, physiologists, psychologists, and industrial engineers. Papers in the first consider temperature, lighting, and other factors producing human fatigue, and record results of studies of its effects. Typical subjects discussed in the second are range and strength of joint movement, response to variously designed visual indicators, and equipment layout.

Tables of Integral Transforms, Volume 2. Compiled by the Staff of the Bateman Manuscript Project. McGraw-Hill Book Company, Inc., New York, N. Y., 1954. 451 p., $9^1/_4 \times 6^1/_4$ in., bound. $8. Somewhat more than half of this second, and last, volume contains tables of further integral transforms—Hankel transforms and other integral transforms whose kernel is a Bessel function, fractional integrals, Stieltjes, and Hilbert transforms. The remainder of the volume contains integrals of higher transcendental functions.

Technology of Solvents and Plasticizers. By Arthur K. Doolittle. John Wiley & Sons, Inc., New York, N. Y., 1954. 1056 p., $9^1/_4 \times 6$ in., bound. $18.50. Both the theory and practice of the subject are treated in an attempt to relate the general technology to basic scientific knowledge. Coverage is limited to organic solvents for processing resinous substances used in textiles, adhesives, and surface coatings; and to plasticizers used for adhesives, surface coatings, and plastics (hot-processing types). Sections on properties of 161 solvents and 131 plasticizers occupy about half the book.

Textbook of Servomechanisms. By John C. West. English Universities Press Ltd., London, England (available in U. S. from The Macmillan Company, New York, N. Y.), 1953. 238 p., $8^3/_4 \times 5^3/_4$ in., bound. $5. This is an introduction to the subject for undergraduates and for engineers who are not specialists in the field. A simple system is described and used, with modifications and additions, to develop the theory and behavior of control systems and their characteristics.

Water Conditioning for Industry. By Sheppard T. Powell. McGraw-Hill Book Company, Inc., New York, N. Y., first edition, 1954. 548 p., $9^1/_4 \times 6^1/_4$ in., bound. $9. Fundamentals of processes, typical installations, and operating techniques of a wide range of water-conditioning methods are described. These include coagulation, filtration, softening, demineralization, deaeration, and others. Allied subjects such as steam-contamination correction, corrosion of metals, electrolytic-corrosion control, boiler scales, etc., are also discussed. Emphasis is on preparation of water for high-pressure boilers and processes covered are widely applicable.

ASME BOILER AND PRESSURE VESSEL CODE . . .

Interpretations

The Boiler and Pressure Vessel Committee meets monthly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in Mechanical Engineering.

(The following Case Interpretations were formulated at the Committee meeting October 29, 1954, and approved by the Board on December 30, 1954.)

Case No. 1194

(Special Ruling)

Inquiry: Is it permissible in welded construction conforming to the requirements of Section VIII to use nickel-chromium-molybdenum wrought-material forgings which meet the chemical and physical requirements contained in Table 1?

Reply: It is the opinion of the Committee that nickel-chromium-molybdenum wrought plates, pipes, forgings, and bolting having the chemical and physical requirements specified in the Inquiry may be used in the construction of arc-welded pressure vessels complying with the rules of Section VIII, provided the following additional requirements are met:

(1) The rules in Subsection C which shall apply are those given in Part UNF.

TABLE 1—CASE NO. 1194

CHEMICAL REQUIREMENTS

	Per Cent		Per Cent
Chromium	14.50–16.50	Silicon, max	1.00
Molybdenum	15.00–17.00	Cobalt, max	2.50
Tungsten	3.00– 4.50	Manganese, max	1.00
Iron	4.00– 7.00	Vanadium, max	0.35
Nickel	Remainder	Phosphorus, max	0.040
Carbon, max	0.08	Sulfur, max	0.030

PHYSICAL REQUIREMENTS

Thickness, In.	Tensile Strength, Min, Psi	Yield Strength, 0.2% Offset Min, Psi	Elongation in 2 In., Min, Per Cent
Up to $^3/_{16}$	115,000	50,000	40
$^3/_{16}$ through $^3/_4$	100,000	45,000	30
Over $^3/_4$ to $1^1/_2$	90,000	45,000	20

TABLE 2—CASE NO. 1194

Metal Temp Not Exceeding Deg F	Maximum Allowable Stress Values, Psi: Sheet and Plate	Bolting
100	22,000	10,000
200	20,000	10,000
300	20,000	9,200
400	20,000	9,000
500	20,000	8,500
600	20,000	8,500
700	19,000	8,500
800	19,000	8,500
900	18,000	8,500
1000	18,000	8,500

(2) The maximum allowable stress values for the material shall be those given in Table 2.

(3) All butt-welded joints shall be examined radiographically for their full length as prescribed in Par. UW-51 when the plate or vessel wall thickness exceeds $^3/_8$ in.

(4) All butt-welded joints and all nozzle-connection welds shall be examined for the detection of cracks by the fluid-penetrant method.

(5) Welding shall be done by the arc-welding process using filler metal that complies with the chemical and physical requirements given in the Inquiry.

(6) The welding procedures and welders shall be qualified under the requirements of the 1953 Edition of Section IX, Part B, except that the tensile strength of the reduced-section specimen shall not be less than the minimum tensile specified for the material in the Inquiry.

(7) The requirements in Par. UNF-65 shall apply to low-temperature operation.

CASE No. 1195

(Special Ruling)

Inquiry: May Fig. UNF-28.10-1, covering copper-silicon alloys A and C and extending the range to 350 F, be used in place of Fig. UNF-28.10?

Reply: It is the opinion of the Committee that Fig. UNF-28.10-1, covering copper-silicon alloys A and C, is to replace the present Fig. UNF-28.10 printed in the 1954 Addenda to Section VIII.

(NOTE: Fig. UNF-28.10-1, Chart for Determining Shell Thickness of Cylindrical and Spherical Vessels Under External Pressure When Constructed of Copper-Silicon Alloys A and C, is available from the Secretary of the Boiler and Pressure Vessel Committee and will be included in the printed Case Interpretations.)

Cases Annulled

The following cases are annulled for the reasons given.

NONFERROUS MATERIALS

Case No. 1127—This case permits a change in the specification limits for silicon and manganese in Type A material under SB-96 and SB-98. These limits have now been adopted in the revised specifications in Section II.

Case No. 1151—This case refers to the 1949 Edition of Section VIII and is to be included with the group annulled as of January 1, 1955.

Case No. 1179—This case covers Figs. UNF-28.6, UNF-28.7, and UNF-28.8 for nickel vessels under external pressure. They are now included in the 1954 Addenda.

Case No. 1183—This case covers Figs. UNF-28.9 to UNF-28.12 inclusive for copper vessels under external pressure. They are now included in the 1954 Addenda.

UNFIRED PRESSURE VESSELS

Case No. 989—This case covers three grades of SA-268 chromium steel pipe which were added to Table UHA-23 in the 1954 Addenda.

Case No. 1118—This case covers two grades of SA-350 forgings for low-temperature service which were added to Table UCS-23 in the 1954 Addenda.

Case No. 1163—This case involves testing heat-exchangers which is covered by revisions to Par. UG-99 in the 1954 Addenda.

Case No. 1164—This case provides a design chart for vessels under external pressure which is covered by inclusion of the chart as Fig. UCS-28.2 in the 1954 Addenda.

Proposed Revisions and Addenda to Boiler and Pressure Vessel Code...

AS NEED arises, the Boiler and Pressure Vessel Committee entertains suggestions for revising its Code. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Comments should be addressed to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Power Boilers, 1952

TABLE P-7 Under CASTINGS, CARBON STEEL, SA-216-53T (Carbon-Steel Castings Suitable for Fusion Welding for High-Temperature Service), the stress values now shown in this Table still remain for this specification of revised date.

Heating Boilers, 1952

PAR. H-74 Add the following after the word "Locomotives" in the tenth line: "or Specification SA-212 for high-tensile-strength carbon-silicon steel plates."

PAR. H-76 Add a new paragraph to read: "When SA-212 plates are used in the construction of boilers, this material shall be used in qualifying the procedure."

PAR. H-77(a) Add the following sentence to the end of the paragraph: "Welders who will weld SA-212 plates must be qualified with that material."

PAR. H-78(b) Add the following sentence: "Welders who will weld SA-212 plates must be qualified with that material."

Unfired Pressure Vessels, 1952

PAR. UG-127(e)(3) Revise editorially to read:

(3) The disk is designed to rupture at not more than the maximum allowable working pressure of the vessel.

PAR. UG-133(f) Revise editorially to read:

(f) The set pressure tolerances, plus or minus, of safety or relief valves, shall not exceed 2 psi for pressures up to and including 70 psi; and 3 per cent for pressures above 70 psi.

PAR. UW-51(b) Revise the table in this paragraph to read:

Plate Thickness, In.	Thickness of Reinforcement, In.
Up to $^1/_2$ incl.	$^1/_{16}$
Over $^1/_2$ to 1	$^3/_{32}$
Over 1 to 2	$^1/_8$
Over 2	$^5/_{32}$

PAR. UW-51(e)(1) Revise this paragraph to read:

(1) The penetrameters shall be placed on the side nearest the radiation source except when complying with the provisions given in Par. UW-51(g).

PAR. UW-51(g) In footnote 1, substitute the words "source of radiation" for the words "source of gamma rays" wherever they appear.

Revise this subparagraph to read:

(g) Penetrameters may be placed on the film side of the joint provided the manufacturer can satisfy the inspector that the technique employed in doing the work is known to be adequate.[1]

TABLE UCS-23 Under CASTINGS, CARBON STEEL, SA-216-53T (Carbon-Steel Castings Suitable for Fusion Welding for High-Temperature Service), the stress values now shown in this Table remain for this specification of revised date.

Welding Qualifications, 1953

TABLE Q-11.1 Add the following specifications where indicated:

		P-Number
SA-369-53T	Grades FP1 and FP2	P-3
SA-369-53T	Grades FP3b, FP11 and FP12	P-4
SA-369-53T	Grades FP21, FP22, FP5, FP7 and FP9	P-5

TABLE QN-11.1 Add the following specification where indicated:

SB-273-53T	Grade GR40A	P-22

With Notes on the Engineering Profession

First Event of ASME Jubilee Year—February 16 The Founding Anniversary Meeting, New York, N. Y.

- **The Engineer and the World of Communications**
- **Leaders in Communications to Address Session**
- **Vannevar Bush Chosen as the Banquet Speaker**

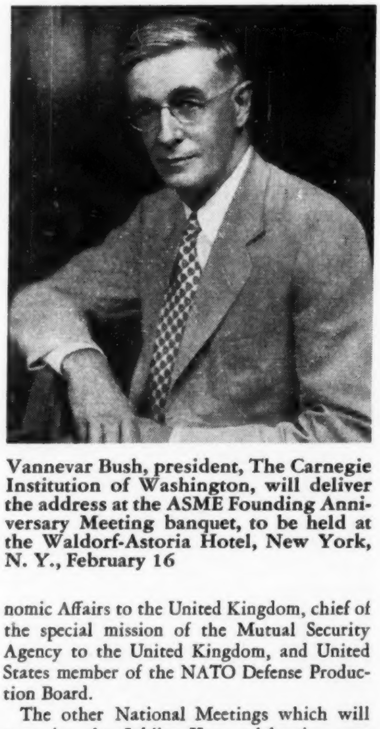
THE Founding Anniversary Meeting, the first of five National Meetings to be held during 1955 to celebrate the 75th Anniversary of The American Society of Mechanical Engineers, will be held February 16.

The first meeting will be held in New York, N. Y. It will commemorate the initial meeting called in the offices of the *American Machinist*, by Prof. John E. Sweet on Feb. 16, 1880, to discuss the formation of a national society for mechanical engineers—a meeting attended by thirty of the leading engineers of that day, who discussed the plans for the establishment of an organization for the "collection and diffusion of definite and much needed information."

The theme of the Founding Anniversary Meeting is "The Engineer and the World of Communications." The schedule for the all-day program appropriately begins with a morning session to be held in the Auditorium of the McGraw-Hill Publishing Company, publishers of *American Machinist*. The session will be devoted to a panel discussion of the relationship of the engineer to the field of communications. ASME President David W. R. Morgan will address the group in the morning, and at that event, greetings from other technical associations and societies to the Society will be presented.

Following a buffet luncheon the meeting will adjourn to the Engineering Societies Building, where an afternoon session will hear talks by such leaders in the field of communications as Edgar Kobak; James G. Lyne, Affiliate ASME; Ormand J. Drake; and E. W. Engstrom.

Dr. Vannevar Bush, president, The Carnegie Institution of Washington, has been selected as banquet speaker; the topic of his talk is "Communications—Where Do We Go From Here?" The banquet will be held in the Sert Room of the Waldorf-Astoria Hotel. Toastmaster at the banquet will be William L. Batt, past-president and Hon. Mem. ASME, and former president of S.K.F. Industries. From 1950 to 1952 Mr. Batt was Minister of Economic Affairs to the United Kingdom, chief of the special mission of the Mutual Security Agency to the United Kingdom, and United States member of the NATO Defense Production Board.



Vannevar Bush, president, The Carnegie Institution of Washington, will deliver the address at the ASME Founding Anniversary Meeting banquet, to be held at the Waldorf-Astoria Hotel, New York, N. Y., February 16

The other National Meetings which will comprise the Jubilee Year celebration are: April 16, Stevens Institute of Technology, Hoboken, N. J., anniversary of ASME's first organization meeting, devoted to the theme, "The Engineer and the World of Education"; April 18–22, Baltimore, Md., Spring Meeting, devoted to the theme of "The Engineer and the World of Government"; June 19–23, Boston, Mass., Semi-Annual Meeting, devoted to the theme of "The Engineer and the World of Science"; and November 13–18, Chicago, Ill., Annual Meeting, devoted to the theme of "The Engineer and the World of Commerce and Industry."

The program for the Founding Anniversary Meeting follows:

WEDNESDAY, FEBRUARY 16

10:30 a.m.

Special Commemorative Session

(By invitation only)

Auditorium—33rd floor, McGraw-Hill Publishing Co., 330 West 42nd Street, New York, N. Y.

Chairman: *Burnham Finney*, editor, *American Machinist*

Welcome: *Donald McGraw*, president, McGraw-Hill Publishing Company

Presentation of greetings to ASME from associations and societies representing the various communications media and fields

Address: *David W. R. Morgan*, ASME President

12:00 noon

Registration

Lobby, Engineering Societies Building, 29 West 39th Street, New York, N. Y.

1:30 p.m.

Tour of Engineering Societies Library, 13th floor, Engineering Societies Building

2:15 p.m.

General Session

(Open to members and guests)

Auditorium—third floor, Engineering Societies Building

Panel Session: The Engineer and His Communications

Chairman: *Willard T. Chevalier*, executive vice-president, McGraw-Hill Publishing Company

The Engineer's Communications With Those Outside His Profession, by *Edgar Kobak*, business consultant, New York, N. Y.

The Engineer's Communications With Other Engineers, by *James G. Lyne*, president, Simmons-Boardman Publishing Company, New York, N. Y.

The Engineer's Personal Communications Through Writing and Speaking, by *Ormand J. Drake*, professor, assistant secretary, New York University, New York, N. Y.

What the Engineer Has Meant to Communications, by *E. W. Engstrom*, executive vice-president, research and development, Radio Corporation of America, New York, N. Y.

7:00 p.m.

Banquet

Sert Room, Waldorf-Astoria Hotel, New York, N. Y.

Toastmaster: *William L. Batt*, past-president and Hon. Mem. ASME.

Presentation of Honors and Awards

Address: *Vannevar Bush*, president, The Carnegie Institution of Washington

Subject: **Communications—Where Do We Go From Here?**

(*Attendance is limited to 400.*)

ASME Representatives Join NBS Advisory Committees Recently Established

During the past year 12 technical-area advisory committees have been established to provide a direct, continuing link between the National Bureau of Standards and the organized science and technology of the nation. Nine scientific and engineering societies have nominated advisory committees to the Bureau in the fields of physics, chemistry, mathematics, metallurgy, ceramics, and electrical, radio, civil, and mechanical engineering. J. W. Parker, past-president, ASME, is chairman of the Society's Advisory Committee. In addition, the National Conference on Weights and Measures, the American Society for Testing Materials, and the American Standards Association have designated groups at the Bureau's request to advise in their areas of special interst.

These committees, which will supplement the Bureau's Statutory Visiting Committee, have been set up as a result of recommendations made by the Ad Hoc Evaluation Committee appointed by the Secretary of Commerce in April, 1953, to evaluate the Bureau's program in relation to national needs. Under the chairmanship of Mervin J. Kelly, president of Bell Telephone Laboratories, the Evaluation Committee conducted a comprehensive survey and reported in October, 1953, that the Bureau's statutory functions were well conceived and its operations generally sound. At the same time, however, the Committee recognized the desirability of some means whereby the needs of the nation's scientific and engineering societies could be expressed and transmitted to the Bureau for implementation in its program.

In general, the functions of the advisory committees are twofold. First, each committee plays an external role, in which its members represent formally the interests and needs of their society and interpret its point of view in terms of the NBS program. To encourage objectivity in this function, the advisers are nominated by their society and serve as a committee of the society rather than a committee of the Bureau.

The second function, which might be called an internal one, involves assistance to the Bureau on more detailed problems of program formulation and evaluation. Here the committee members work in small groups or panels directly with the heads of the Bureau's various laboratories. Specific advice is given on technical procedures, and suggestions may be made regarding the initiation or possible abandonment of certain lines of endeavor.

The advisory committees have now selected their chairmen and have held one or more meetings at the Bureau. The general areas of interest of the various groups have been largely delineated, and some recommendations have been made. It is felt that the special committees will prove a valuable source of consultation and stimulation which will strengthen the ties of the Bureau with American science and industry.

Because of considerable overlapping of interests, the advisory committees from the American Society of Civil Engineers and The American Society of Mechanical Engineers plan to work very closely with each other. The two groups have been holding joint meetings at the Bureau. Among the interests of the ASCE committee is the Bureau's work in building technology. In this field the Bureau conducts laboratory research on technical problems relating to building construction and maintenance, and assists Government and industry in applying scientific principles and data to building design. The ASME advisory group's many interests include the Bureau's program in mechanics, which involves work in aerodynamics and in structural properties of materials. Other programs of concern to this group include thermodynamics, automotive and aircraft fuels and lubricants, and the length standardization and gage calibration work which is basic to the control of dimensions in mass production. Chairmen of the ASME and ASCE groups are James W. Parker of the Detroit Edison Company and G. H. Hickox of the National Science Foundation, respectively.

In addition to Dr. Parker, the personnel of the ASME Advisory Committee is composed of the following: Prof. Dana Young, Yale University; Prof. S. R. Beitler, Ohio State University; Prof. C. Harold Berry, Harvard University; Prof. A. P. Colburn, University of Delaware; and Paul V. Miller, The Taft-Peirce Manufacturing Company.

C. H. Shumaker, *left*, Vice-President, ASME Region VIII, presents charter to J. M. Flanagin, Jr., chairman, Sabine Section, before a large audience including members from other local engineering societies. The presentation ceremony was held during a dinner meeting in the Crystal Ballroom, Hotel Edson, Beaumont, Texas.

ASME Membership as of Dec. 31, 1954

Honorary Members	56
Fellows	394
Members	14,421
Affiliates	315
Associate Members (33 and over)	3,601
Associate Members (30–32)	3,168
Associate Members (to the age of 29)	18,303
Total	40,258

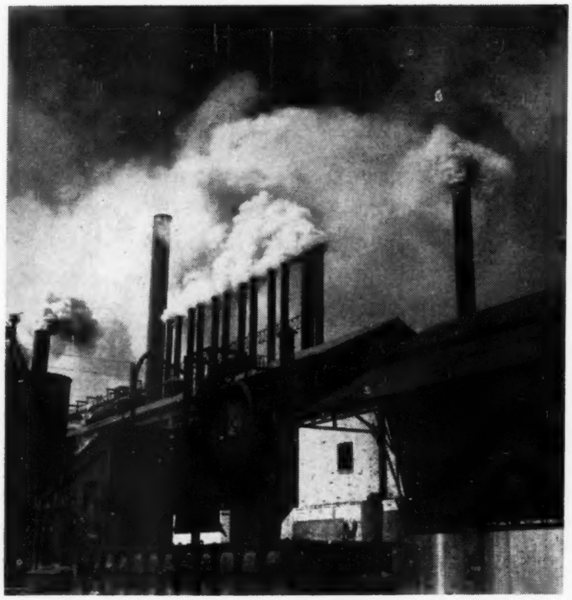
Government-Industry Research Leaders Seek Mutual Benefits

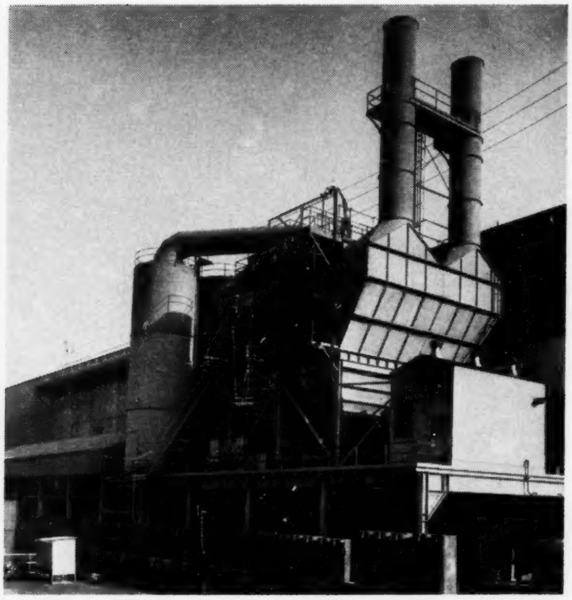
The National Academy of Sciences-National Research Council has been asked by officials of both industry and Government to establish within the Academy-Research Council framework a committee to concern itself with the common interests and relationships of industrial and governmental research, particularly in the area of applied research.

Conferences between industrial and governmental research executives and directors, called by the Academy-Research Council, recommended that a small committee be organized to explore the need for better acquaintance and understanding between Government and industry research leaders, and to consider methods for accomplishing this objective. As a result, the Government-Industry Research Committee has been organized by the Academy-Research Council with the following membership: Edgar C. Bain, United States Steel Corporation, chairman; Allen V. Austin, National Bureau of Standards; D. P. Barnard, Deputy Assistant Secretary of Defense, Research and Development; Ralph Bown, Bell Telephone Laboratories, Inc.; Ralph Connor, Rohm and Haas Company; Hugh L. Dryden, Fellow ASME, National Advisory Committee for Aeronautics; Paul D. Foote, Gulf Research and Development Company; G. E. Hilbert, Agricultural Research Service, U. S. Department of Agriculture; Randolph Major, Merck and Company, Inc.; Roy C. Newton, Swift and Company; and Alan T. Waterman, National Science Foundation.

At its first meeting the Committee concluded that effective mechanisms already exist in many fields for furthering mutually helpful relations between government and industry research. However, the Committee agreed to hold itself available as necessary to assist in exchanging views and ideas designed to improve such relations where either Government or industry groups may feel this to be desirable.

When its services are requested, the Committee proposes to consider first the extent to which the need can be satisfied by existing mechanisms. If appropriate, the Committee will then consider designation of an ad hoc group of individuals active in the particular field concerned to assist in bringing about improved understanding and closer relationships.



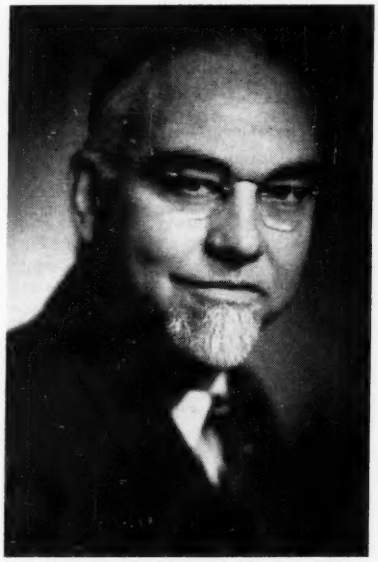


Operation of Isabella Ferromanganese Furnace, *left,* at Etna, Allegheny County, Pa., was discontinued in 1953 in part, at least, for its contribution to air pollution. It was replaced by a modern installation incorporating control by electrostatic precipitation at Duquesne, Pa. Electrostatic precipitator, *right,* installed to clean gases from steel electric furnaces. Note complete absence of fumes. (*Photos, courtesy of U. S. Steel Company.*)

ASME Congress on Air Pollution Seeks Solution to Problems

American and Foreign Authorities to Participate; Sir Hugh Beaver, Rice Lecture; G. E. Pendray, Banquet Speaker

The program of the First International Congress on Air Pollution, sponsored by the Committee on Air Pollution Controls of The American Society of Mechanical Engineers indicates the wide scope of participation both by authorities from the United States and from The Netherlands, Germany, Portugal, France, and England. The Congress will be held in New York, N. Y., March 1 and 2, 1955, at the Hotel Statler.



G. Edward Pendray, banquet speaker, ASME Congress on Air Pollution. (*Jean Raeburn photo.*)

G. E. Pendray, Banquet Speaker

G. Edward Pendray, a public-relations counselor of national reputation, author, and one of the country's foremost proponents of rocket and jet propulsion, will discuss problems which air pollution poses for the businessman. He will emphasize that these problems present management with either a remarkable opportunity for better relations with the public or a dangerous threat to the company's reputation. He will describe and analyze the viewpoint which top business management should take toward air-pollution control.

Rice Lecture by Sir Hugh Beaver

The Calvin W. Rice Lecture will be presented by Sir Hugh Beaver, chairman, British Government committee investigating the London smog of 1952. The report by the committee showed that 4000 persons died of complications at that time, but that the London smogs could be banished. It found that air pollution was "a social and economic evil of the first magnitude," and said it was costing the country £250,000,000 ($700 million) a year.

Nearly half the smoke in London is from home coal fires, the report added, and it was recommended that smokeless fuel be made available where electric and gas heating are not feasible. Power plants would have until 1964 to install smoke-washing equipment, according to the report.

The tentative program follows:

TUESDAY, MARCH 1

9:30 a.m. **Penn Top South**

Gaps in Our Knowledge of Air Pollution

Chairman: *Leonard Greenburg,* MD, Commissioner, Department of Air Pollution Control, New York, N. Y.

Co-chairman: *Milton Reizenstein,* smoke abatement engineer, Baltimore, Md.

Biological Aspects of Air Pollution: Needed Research, by *Norton Nelson,* PhD, director, Institute of Industrial Medicine, New York University-Bellevue Medical Center, New York, N. Y.

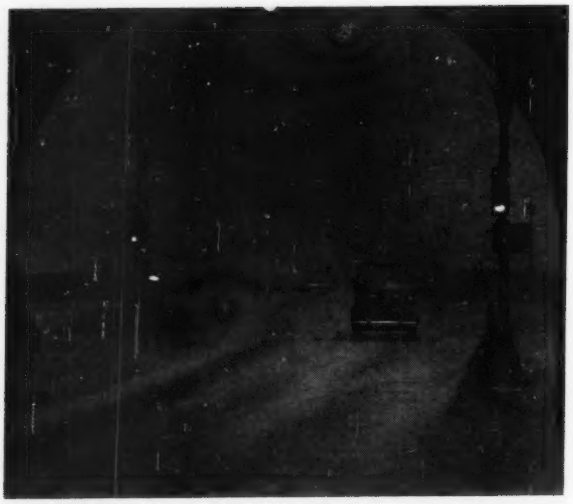
Air-Pollution Control: Administrative Needs and Patterns, by *Arthur C. Stern,* Mem. ASME, chief, Air Pollution Control Program, U. S. Public Health Service, Department of Health, Education and Welfare, Cincinnati, Ohio

Air-Pollution Control: Needed Engineering Research and Development, by *Leslie Silverman,* ScD, associate professor of industrial hygiene engineering, school of public health Harvard University, Boston, Mass.

2:00 p.m. **Penn Top South**

(*Continued from Morning Session*)

Unsolved Meteorological Problems in Air-Pollution Control, by *E. Wendell Hewson,* professor



View of the Golden Triangle, Pittsburgh, Pa., from the Liberty Tubes before smoke control, *left*, and after smoke control, *right*. *(Photos, courtesy of T. C. Wurts.)*

of meteorology, University of Michigan, Ann Arbor, Mich.

Biological Systems for the Identification and Distribution of Air Pollutants, by *John T. Middleton*, PhD, Department of Plant Pathology, University of California Citrus Experiment Station, Riverside, Calif.

Air-Pollution Control. Associated Health Implications, by *E. A. Watkinson*, MD, chief, Occupational Health Division, Department of National Health and Welfare, Ottawa, Ont., Can.

9:30 a.m. **Penn Top North**

Current Problems in Air Pollution

Exhaust Gases From Diesel Engines, by *Rogers F. Davis* and *John C. Holtz*, Diesel Test and Research Section, Bureau of Mines, U. S. Department of the Interior, Pittsburgh, Pa.

Incinerator-Design Standards: Research Findings, by *Andrew H. Rose, Jr.*, Assoc. Mem. ASME, head engineer, Los Angeles County Air Pollution Control District, Los Angeles, Calif.

Measurement of Average Particle Size in Aerosols by Light Scattering, by *David Sinclair*, senior research physicist, Johns-Manville Research Center, Manville, N. J.

The Sarnia Survey: Action Without Compulsion, by *B. C. Newbury*, research fellow, Ontario Research Foundation, Toronto, Ont., Can.

6:30 p.m. **Sky Top**

BANQUET

Presiding: *R. J. S. Pigott*, past-president, ASME.
Management Aspects of Air Pollution, by *G. Edward Pendray*, Pendray & Company, New York, N. Y.

Films to Be Shown During the Meeting

"Wind-Tunnel Scale-Model Investigation of Power Plants"

Presented by

Engineering Research Laboratory
New York University
New York, N. Y.

* * *

"Guilty Chimneys"

Presented by

The Gas Council, London, England

Presentation of Honorary ASME Membership to Sir Hugh E. C. Beaver by David W. R. Morgan, ASME President and vice-president, Westinghouse Electric Corporation, Pittsburgh, Pa.

WEDNESDAY, MARCH 2

9:30 a.m. **Penn Top South**

Sulphur Dioxide—Treatment and Recovery

Chairman: *Louis C. McCabe*, PhD, chief, Fuels and Explosives Division, Bureau of Mines, U. S. Department of the Interior, Washington, D. C.

Co-chairman: *Gordon R. Milne*, Mem. ASME, mechanical engineer, Consolidated Edison Company of New York, Inc., New York, N. Y.

The World Supply of Sulphur, by *J. C. Carrington*, vice-president, Freeport Sulphur Company, New York, N. Y.

The Removal of Sulphur Dioxide From Power-Plant Stack Gases, by *R. L. Rees*, chief chemist, British Electricity Authority, Bankside House, London, England

Recovery of Sulphur Dioxide From Coal-Combustion Stack Gases. Pilot-Plant Studies of an Ammonia-Scrubbing Process, by *L. B. Hein*, chief, Defense Processes, Tennessee Valley Authority, Wilson Dam, Ala.

The Ammonia Process for the Removal of Sulphur Dioxide From Flue Gases, by *H. E. Newall*, Department of Scientific and Industrial Research, Fuel Research Station, London, England

2:00 p.m. **Penn Top South**

Refinery-Sulphur Recovery Aids Air-Pollution Control, by *G. E. Smalley* and *James W. Klohr*, The Ralph M. Parsons Company, Los Angeles, Calif.

Recovery and Utilization of Sulphur From Coke-Oven Gas, by *J. K. Kurtz*, Bethlehem Steel Company, Sparrows Point, Md.

Air-Pollution Control by a Sulphur-Dioxide Scrubbing System (Speaker to be announced), Olin Mathieson Chemical Corporation, Little Rock, Ark.

Sulphur in Iron and Steelmaking, by *T. P. Colclough*, C.B.E., DSc, M.Met., technical adviser, British Iron and Steel Federation, Steel House, London, England

Experience in Air Pollution Abroad

9:30 a.m. **Penn Top North**

Influence of the Size of the Dust Outlet of Cyclones on Their Efficiency, by *H. J. Van Ebbenhorst Tengbergen*, engineer, Mining Division, Staatsmijnen in Limburg, Centraal Proefstation, Treebeek, The Netherlands

Experience With Air Pollution in Holland, by *A. J. Ter Linden*, professor engineer, Technische Hogeshool Laboratorium voor Warmte en Stoftechnieck, Delft, The Netherlands

Abiotic Disease in Forest Stands Caused by Sulphurous Gases, by *Natalina Ferreira das Santos Azevedo*, Estacao Agronomica Nacional Sacvaem, Portugal

2:00 p.m. **Penn Top North**

Air Pollution Caused by Combustion Products and Industrial Activity, by *Melchiorre de Chigi*, director, Hygiene Institute, Padua University, Italy

Collective Toxicity in Italy Caused by Industrial Atmospheric Pollution, by *Giovanni Pancheri*, director, Medical Division, Ente Nazionale per la Prevenzione degli Infortuni, Rome, Italy

(Subject to be announced), by *Jean E. Prat*, president, Prat-Daniel, Paris, France

Practical Performance With Test Results of Well-Known Types of Dedusters, by *C. J. Stairmand*, Imperial Chemical Industries Limited, Billingham, Co. Durham, England

Air-Pollution Problems Caused by Dusts and Fumes, by *A. P. Avy*, Engineer in Chief, Laboratoire Central des Services Chimiques de l'Etat. Ministere de l'Industrie et du Commerce, Paris, France

1955 Calvin W. Rice Lecture

4:00 p.m., Tuesday, March 1

Penn Top South

Presiding: *G. V. Williamson*, chairman, ASME Committee on Air Pollution Controls, and vice-president, Union Electric Company of Missouri.

1955 Calvin W. Rice Lecture

Air Pollution: The Growth of Public Opinion

by

Sir Hugh E. C. Beaver

M. Inst. C.E., M.E.I.C., M.I. Chem. E.

Chairman of the Government Committee of Enquiry into the Nature, Causes, and Effects of Air Pollution (United Kingdom)

Registration

Registration will be held in the Penn Top Foyer (18th floor) from 8:00 a.m. to 5:00 p.m. both days of the meeting. Both members and nonmembers are required to register.

Preprints

Preprints of the papers presented at the technical sessions will be on sale in the Penn Top Foyer during both days of the meeting. Preprints are 25 cents each for ASME Members and 50 cents each for nonmembers.

Dedicate America's First Foundry Technical Center

ANOTHER important industry operation moved to suburban quarters when the American Foundrymen's Society located in Des Plaines, Ill., from where technical activities will emanate on an international scale. Dedication ceremonies, held November 18, were attended by over 300 AFS members and guests, with representatives from as far away as Canada. AFS President Frank J. Dost, president of Sterling Foundry Company, Wellington, Ohio, dedicated the building to American industry.

The building project, approximately a $300,000 investment, was made possible by subscriptions from companies, individuals, and AFS chapters, a truly remarkable co-operative effort on the part of a major industry.

The American Foundrymen's Society was founded in 1896 by a group of progressive-minded foundrymen who realized the need for an organization to provide the free exchange of ideas and data on preferred foundry practices. Since that inaugural meeting, held in Philadelphia, Pa., the American Foundrymen's Society has developed into a top-ranking technical society with 54 chapters—38 in the United States, three in Canada, one in Mexico, and 12 student chapters—and a great international membership in 33 countries.

The new permanent headquarters will make it possible for AFS to even broaden and strengthen its activities . . . foundry publications, fundamental research, foundry education, technical service, technical library, safety, hygiene and air-pollution control, foundry conventions and exhibits, and *American Foundryman*, official monthly publication of the society.

National Engineers' Week Is February 20–26, 1955

NATIONAL Engineers' Week will be observed on February 20-26, according to an announcement by Anatole R. Gruehr, chairman of the committee. The purpose of this observance is to bring to the attention of the American public the importance of the engineering profession to America's future.

The theme for 1955 will be "Engineering—Builder of a Brighter Future."

The week of George Washington's birthday has been selected as the period in which to observe the National Engineers' Week in recognition of the engineering accomplishments of our nation's first President. A series of events are being planned for the week of February 20-26 by the National Society of Professional Engineers, who introduced the annual observance of National Engineers' Week, in conjunction with local branches of other engineering societies.

Discussing the unlimited opportunities of an engineering career and the importance of the profession to our American way of life, Mr. Gruehr said that the future prosperity of our country and her very safety are dependent upon continued ingenuity in the engineering application of scientific discoveries to increase productivity and to military preparedness. Yet the creative role of the engineer as a designer, a developer, a production organizer, is rarely understood.

The essential functions of the engineering profession, which have continually raised the American standard of living, are little known to the general public, he observed.

If we are to maintain America's supremacy in adapting new discoveries to the needs of the day, we must have a continuous enlistment in the engineering profession of young men and women gifted with superior creative abilities and daring. These rare individuals, capable of attacking problems in an imaginative, and yet rational manner, able to evaluate facts objectively, and to use rigorous mathematical approach to research, development, and design, are drawn by those fields of endeavor in which they see the best outlets for their creative urge. Too few of them, he concluded, realize that the romance and satisfaction accompanying hard creative work can be found in all branches of professional engineering.

UPADI—Just the Facts

UPADI—What it is: In Spanish it is the Union Pan Americana de Associaciones de Ingenieros. In English it is Pan-American Federation of Engineering Societies. Initiated in Rio in 1949, UPADI includes engineering organizations of about 18 nations; two other nations have organizations that are affiliated. Engineers Joint Council holds the membership for the United States. The headquarters is at present in Montevideo.

UPADI is an engineering organization which preserves the independence of member societies in their own activities and at the same time provides a new means for increased co-operation among engineers and industry of the Western Hemisphere. The objectives of promoting unity among engineers and progress in science and technology are obtained by encouraging, guiding, and standardizing the efforts of engineers in the Americas; by holding periodic Pan-American Engineering Congresses, Conventions, and Exhibits; by encouraging travel of engineers among the American nations and the exchange of teachers, lecturers, and students among the universities and schools and engineering associations; by developing rules of professional practice and codes of professional ethics; by contributing to closer technical relations among the American countries; and by advancing the economic development of all American nations.

What it does: In addition to the initial meeting in Rio in 1949, UPADI has held three conventions at which subjects of interest on engineering education, standards, code of ethics, engineering phases of industrial and economic development, and others have been discussed. A copy of the Professional Code of Ethics may be obtained from Engineers Joint Council. (Unofficially and from the viewpoint of the United States, one of the objectives in connection with hemispheric solidarity is to keep the American nations looking to each other—rather than to Europe—for standards, specifications, and engineering guidance in general. Also to increase the circulation of engineering periodicals in the American nations.)

UPADI Fund, Inc.: On September 3, 1953, under the laws of the State of New York, UPADI Fund, Inc., was officially brought into being. No dues are assessed against member organizations. It is the business of the UPADI Fund, Inc., to obtain the money to meet the operating budget of UPADI. Effective action to accomplish the fund raising is getting under way, and contributions to UPADI Fund, Inc., are now being received from industrial and trade organizations and from individuals.

Convention: The next convention of UPADI will be held in Mexico City during 1956. James M. Todd, a past-president of ASME, is president of UPADI Fund, Inc., and vice-president of UPADI.

1955 Society Records Sent Upon Request

ANY member of The American Society of Mechanical Engineers who has need for a copy of the ASME Membership List (AM-1) of January, 1955, or the 1955 issue of Personnel of Council, Boards, and Committees (AC-10) may obtain them by addressing their requests to the Secretary, ASME, 29 West 39th Street, New York 18, N. Y.

Meetings of Other Societies...

Feb. 18–19
National Society of Professional Engineers, annual spring meeting, Hotel Charlotte, Charlotte, N. C.

March 1–3
Western Computer Conference and Exhibit, sponsored jointly by AIEE, IRE, Association for Computing Machinery, Hotel Statler, Los Angeles, Calif.

March 7–11
National Association of Corrosion Engineers, 11th annual conference and exhibition, Palmer House, Chicago, Ill.

March 14–15
Steel Founders' Society of America, annual meeting, Drake Hotel, Chicago, Ill.

March 14–18
American Society of Tool Engineers, 23rd annual meeting in conjunction with first ASTE Western Industrial Exposition, daytime technical sessions at Shrine Auditorium, evening sessions at Ambassador Hotel, Los Angeles, Calif.

March 15–17
American Institute of Electrical Engineers, utilization of aluminum conference, William Penn Hotel, Pittsburgh, Pa.

March 16–18
Pressed Metal Institute, sixth annual spring meeting, Hotel Carter, Cleveland, Ohio

(*ASME Calendar of Coming Events, see page 192*)

C. C. Furnas, Mem. ASME, Inaugurated Chancellor, University of Buffalo

Universal college education is proof that America developed morally, as well as materially and scientifically, said Dr. Furnas

The dawning age of almost universal college education is proof that America has progressed morally even more than scientifically and materially, Clifford C. Furnas, Mem. ASME, said during ceremonies inaugurating him as Chancellor of the University of Buffalo, Buffalo, N. Y., Jan. 7, 1955.

Dr. Furnas pointed out that college education for everyone capable of absorbing it is fast-becoming a part of the twentieth century—a century which, as the historian Toynbee wrote, will not be remembered primarily for world wars, the automobile, airplanes, antibiotics, nor even nuclear energy, but rather for "having been the first age since the dawn of civilization, some five or six thousand years back, in which people dared to think it practicable to make the benefits of civilization available to the whole human race."

To fulfill this promise, the University of Buffalo and most American universities must double in size before 1970. The growth is made necessary by the great increase in the number of young people eager and able to go to college and the demands of national defense. "It is no secret that Russia alone is now turning out about twice as many college graduates in science and engineering as the United States," Dr. Furnas continued.

University of Buffalo Plans

To provide a college education for all who will want it in 1970, the University of Buffalo will have to create facilities for about 20,000 students, in contrast to its present enrollment of about 10,000. The university's staff will have to be increased about 75 per cent. Its present budget of about five-million dollars a year will have to grow to about ten million. About $15 million worth of new buildings will be needed.

Charity will not be enough to provide the necessary facilities, Dr. Furnas emphasized. "In recent years," he said, "some of the more farseeing lumber companies have established the policy of planting seedlings for the future—at least 50 years in the future. This practice has been established as a legitimate business expense within the framework of the existing tax legislation and the mores of the stockholders. The analogy to the industrial support of education is, I believe, clear. If support of small trees is a legitimate business expense, is not the fostering of education of young men and women who will in the near future be the principals in business and industry even more legitimate and desirable? To activate this analogy will require but little change in the present legal pattern, but it will call for a substantial shift in American business psychology. Unless such a change is forthcoming, it is my belief that private colleges and universities cannot long continue to play a vital role in American education."

The burden of industry will be heavy, Dr. Furnas continued, but "the demands are more than balanced by the trend toward increasing productivity, the steady growth toward more and more real wealth." One thing is sure, Dr. Furnas emphasized: the public pressure for education is not to be denied. "The only question to be decided is the route," he said. "Shall it be the single taxpayer's lane or the dual highway of private as well as public support? We will probably be able to discern the trend of the national answer within the next few years. My firm conviction is that if we are wise, as a nation we will continue along the double highway."

Academic Freedom

The real danger to academic freedom and individuality lies not so much in demagogues as in the mass-production techniques universities may be forced to adapt, Dr. Furnas continued. "When we have ten-million youths in the colleges and universities, it will be easy to fall into the mass-production techniques and, unwittingly, the virtues of academic freedom and individuality may suffer some real defeats," he said. "A creeping paralysis rather than direct frontal attacks is the enemy which I fear most."

It is almost certain that the urban university will be increasingly important in this century of universal college education, Dr. Furnas pointed out. "With slowly rising real incomes a substantial proportion of parents can spend a modest amount on a college education for their children. But for the foreseeable future, the majority will not have the means to send them to distant, expensive universities—particularly in view of the heavy tax structure. Further, the college student often has better opportunities for self-help in his own community than he has elsewhere, particularly if his educational schedule is fairly flexible. The urban university is becoming the university of the middle class, and the middle class is beginning to encompass all of America."

A two-day program was held as part of the inauguration celebration. The Honorable Harold E. Talbott, Secretary of the Air Force, was the principal speaker at a Civic Dinner, held Thursday, January 6, at the Hotel Statler.

Roy E. Larsen, president of Time, Inc., and chairman of the National Citizens Commission for the Public Schools, addressed the third annual University of Buffalo Alumni Luncheon, Friday, January 7, in the Clark Memorial Gymnasium, and Arthur S. Adams, president of the American Council on Education, spoke at the inaugural ceremony Friday evening, January 7, at Kleinhans Music Hall.

Nine professional symposiums were held on the University campus Friday morning, and three general-interest meetings were held Friday afternoon.

ASME Calendar of Coming Events

Feb. 16
The Founding Anniversary Meeting, McGraw-Hill Building, New York, N. Y.
(No formal papers will be presented)

March 1–2
First International Congress on Air Pollution, Hotel Statler, New York, N. Y.
(Final date for submitting papers was Nov. 1, 1954)

March 20–23
ASME Heat Transfer Division and the American Institute of Chemical Engineers Symposium, Louisville, Ky.
(Final date for submitting papers was Nov. 1, 1954)

March 23–24
ASME Management Conference, Hotel Statler, Cleveland, Ohio
(Final date for submitting papers was Nov. 1, 1954)

April 6
ASME Machine Design Division Conference, as part of the Centennial Celebration, New York University's College of Engineering, New York, N. Y.

April 16
The Organization Anniversary Meeting, Stevens Institute of Technology, Hoboken, N. J.
(No formal papers will be presented)

April 18–21
Diamond Jubilee Spring Meeting, Lord Baltimore and Southern Hotels, Baltimore, Md.
(Final date for submitting papers was Dec. 1, 1954)

April 25–26
ASME Instruments and Regulators Conference, University of Michigan, Ann Arbor, Mich.
(Final date for submitting papers was Dec. 1, 1954)

June 5–10
ASME Oil and Gas Power Conference, Hotel Statler, Washington, D. C.
(Final date for submitting papers was Feb. 1, 1955)

June 15–17
ASME and The Institution of Mechanical Engineers, London, England, Joint Conference on Combustion, Massachusetts Institute of Technology, Cambridge, Mass.
(Final date for submitting invited papers was Nov. 1, 1954)

June 16–18
ASME Applied Mechanics Conference, Renssalaer Polytechnic Institute, Troy, N. Y.
(Final date for submitting papers was Feb. 1, 1955)

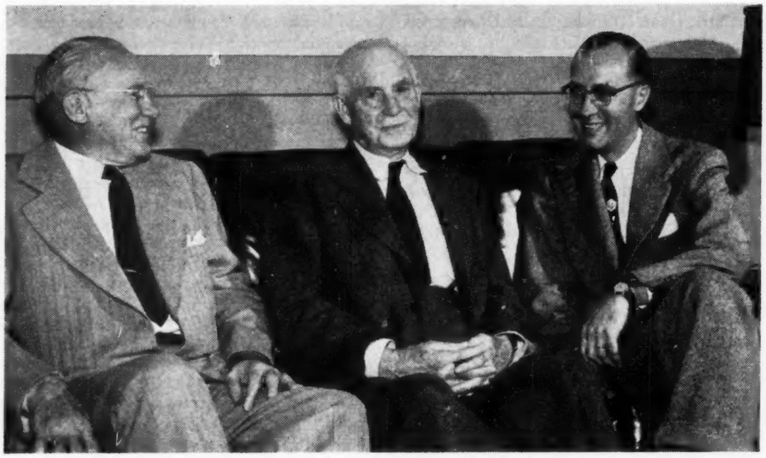
June 19–23
Diamond Jubilee Semi-Annual Meeting, Hotel Statler, Boston, Mass.
(Final date for submitting papers was Feb. 1, 1955)

Sept. 12–16
ASME Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Los Angeles, Calif.
(Final date for submitting papers—May 1, 1955)

Sept. 25–28
ASME Petroleum-Mechanical Engineering Conference, Roosevelt Hotel, New Orleans, La.
(Final date for submitting papers—May 1, 1955)

October 19–20
ASME-AIME Joint Fuels Conference, Neil House, Columbus, Ohio
(Final date for submitting papers—June 1, 1955)

Nov. 13–18
Diamond Jubilee Annual Meeting, Hotel Congress, Chicago, Ill.
(Final date for submitting papers—July 1, 1955)
(For Meetings of Other Societies, see page 191)



Three chief engineers of the Cooper-Bessemer Corporation gather to celebrate the ninetieth birthday of their oldest engineering associate, James H. Debes. Mr. Debes, *center*, was Cooper-Bessemer's chief engineer from 1898 to 1920. He was followed by Hewitt A. Gehres, Mem. ASME, *left*, now director of engineering, who was chief engineer from 1920 to 1935. Ralph L. Boyer, Mem. ASME, *right*, is currently vice-president and chief engineer.

People . . .

Thomas D. Jolly, Fellow ASME, was recipient of The Howard Coonley Medal, which was presented by The American Standards Association on Nov. 17, 1954, during its annual meeting held in New York, N. Y. At the same event, John Gaillard, Mem. ASME, received the Standards Medal.

W. F. Thompson, vice-president, ASME Region I, has been named chairman of the Industrial and Harbor Development Committee of the Citizens Action Commission, New Haven, Conn. The principal task of the commission will be to retain present existing industries and attract new industries; improve city plans and approaching roads; and to develop the harbor, which is deemed to be one of New Haven's greatest natural assets.

William Prager, Mem. ASME, professor of applied mechanics, Brown University's Division of Engineering, delivered the James Clayton Lecture, January 14, at the invitation of The Institution of Mechanical Engineers. The title of Professor Prager's lecture is "The Theory of Plasticity: A Survey of Recent Achievements." While in Europe he will deliver lectures at the invitation of the Swiss Federal Institute of Technology in Zurich; The Sorbonne in Paris; the Technical University of Delft, Holland; The Imperial College of Science and Technology in London, and the University of London.

Warren E. Wilson, Mem. ASME, president of the South Dakota School of Mines and Technology from 1948 to 1953, has been named George Westinghouse professor of engineering education at The Pennsylvania State University. The position is sponsored by Westinghouse Educational Foundation.

M. E. Farris, Mem. ASME, dean, college of engineering, University of New Mexico, will represent ASME at the AAAS Symposium on Arid Lands to be held in New Mexico April 26–May 2, 1955.

James M. Crone, Mem. ASME, a building engineer, Ithaca, N. Y., has been awarded $500 as a second award in a national arc-welding competition sponsored by The James F. Lincoln Welding Foundation.

Robert P. Messenger, Mem. ASME, executive vice-president, International Harvester Company, has been named recipient of the 1955 Cyrus Hall McCormick Medal by the American Society of Agricultural Engineers. Formal presentation will be made during the 47th annual meeting of the society to be held in Urbana, Ill., June 12–15, 1955.

Robert S. Aries, Mem. ASME, chemical and economic consultant, and head of R. S. Aries & Associates, New York, N. Y., has been appointed American Chemical Society lecturer. He will present a talk on "Economics of the Chemical Process Industries" at a number of industrial centers in the Southwest including Arkansas, Texas, and Louisiana. The lecture tour begins February 12.

Ed Sinclair Smith, Fellow ASME, staff technical assistant with the Weapon Systems Analysis Branch, Ballistic Research Laboratories, Aberdeen Proving Ground, Md., has received the 1954 Award of the Instruments and Regulators Division of The American Society of Mechanical Engineers. The award is presented annually to an engineer for outstanding contributions in the field of instrument and regulator research and development.

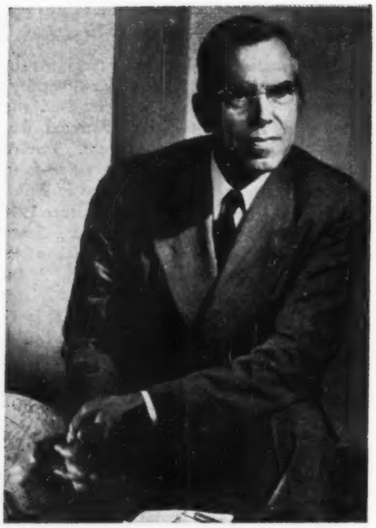
Oliver T. Buckley of Maplewood, N. J., retired president of Bell Telephone Laboratories, Inc., was awarded the 1954 Edison Medal by the American Institute of Electrical Engineers. The presentation of the medal was made during the AIEE meeting on February 2 at the Hotel Statler, New York, N. Y.

C. E. Kenneth Mees, vice-president in charge of research, Eastman Kodak Company, Rochester, N. Y., since 1914, received the Franklin Medal at the annual medal day ceremonies of The Franklin Institute. Twelve scientists, whose fields of study range from photography to steel, were honored in Philadelphia, Pa., on October 20. The other 1954 medalists are: Alfred C. Blaschke, Santa Monica, Calif.; Craig L. Taylor, Los Angeles; C. Levron Eksergian, Mem. ASME, Philadelphia; William Donald Buckingham, Water Mill, L. I.; Clarence Nichols Hickman, Jackson Heights, Queens, N. Y.; Edwin T. Lorig, Pittsburgh; Hans J. Spanner, Zurich; Edmund H. Germer, Irvington, N. J.; Humboldt W. Leverenz, Princeton, N. J.; William Justin Kroll, Corvallis, Ore.; and Kenneth Alva Norton, Boulder, Colo.

John B. Stirling, president, E. G. M. Cape and Company, Montreal, was awarded the Sir John Kennedy Medal for outstanding services toward the development of Canada, to engineering science, and to the profession by The Engineering Institute of Canada for the year 1954. Richard Lankaster Hearn, Toronto, general manager and chief engineer of the Hydro-Electric Power Commission of Ontario, and William George Swan, prominent consulting engineer of Vancouver, have been awarded the 1954 Julian C. Smith medal, one of the top honors awarded by EIC.

Lloyd M. Pidgeon, discoverer of the "Pidgeon Process" for production of metallic magnesium and head of the department of metallurgical engineering, University of Toronto, was recipient of the first Ambrose Monell Medal for distinguished achievement in mineral technology, awarded by Columbia University School of Mines on Nov. 16, 1954.

Brigadier General T. A. Weyher, Mem. ASME, is Commanding General, Rock Island Arsenal, Rock Island, Ill. He assumed command of the Arsenal in December of 1953 and was promoted to the rank of Brigadier General, Ordnance Corps, U. S. Army, on Aug. 18, 1954. General Weyher has been active in the meetings of the Iowa-Illinois Section of the Society and has shown a great interest in the affairs of the Society.



Harry A. Winne, Hon. Mem. ASME, Rexford, N. Y., retired vice-president of General Electric Company, received the 1954 John Fritz Medal awarded by the four Founder Societies. Mr. Winne was honored "for service to his country in war and peace through his distinguished leadership in the electrical industry." The medal was presented February 1, during the AIEE winter general meeting at the Hotel Statler, New York, N. Y. (*Karsh photograph.*)

Charles S. Leopold, prominent Philadelphia, Pa., heating and air-conditioning consulting engineer, was awarded the F. Paul Anderson Medal, highest award of The American Society of Heating and Ventilating Engineers. Formal presentation of the medal took place during the 61st annual meeting of the society at a banquet held at the Bellevue-Stratford Hotel, Philadelphia, Pa., Jan. 26, 1955.

Arthur B. Bronwell, professor, Northwestern University, was elected ninth president of Worcester Polytechnic Institute. For the past seven years Professor Bronwell held the position of executive secretary of the American Society for Engineering Education. He was succeeded in the secretaryship by William L. Collins, professor of theoretical and applied mechanics, University of Illinois.

LaVerne R. Philpott, holder of a Presidential citation for his contribution to the development of the first successful American radar system, has been appointed a co-ordinator in the Research Division of New York University's college of engineering.

Technical Societies Elect Officers:

Barnett F. Dodge, professor and head of the department of chemical engineering at Yale University, has been elected 1955 president of the American Institute of Chemical Engineers. Other officers elected were: Vice-president, Arthur K. Doolittle, assistant director of research, Carbon and Carbide Chemicals Company, S. Charleston, W. Va.; re-elected as treasurer, George G. Brown, dean of engineering, University of Michigan, Ann Arbor, Mich.; executive secretary, F. J. Van Antwerpen, former editor of *Chemical Engineering Progress*, and at present publisher of the AIChE.

William R. Glidden of Richmond, assistant chief engineer of the Virginia Department Highways, became president of the American Society of Civil Engineers. Other officers installed were Frank L. Weaver, Washington, D. C., and Louis R. Howson, Chicago, Ill, vice-presidents; and five new directors.

Joseph H. Humberstone, president, Air Reduction Sales Company, Inc., New York, N. Y., took office as president of The American Welding Society at the 35th annual meeting of the society held in Chicago, Ill. Others who took office include: J. J. Chyle, director of welding research, A. O. Smith Corporation, Milwaukee, Wis., first vice-president; and C. P. Sander, general superintendent, Vernon, Calif., plant of Consolidated Western Steel Division, United States Steel Company, second vice-president.

The American Society of Refrigerating Engineers installed the following national officers for 1955 at the Society's 50th annual meeting held in Philadelphia, Pa., Nov. 28–Dec. 1, 1954: President, Leon Buehler, Jr., chief refrigeration engineer, Creamery Package Manufacturing Company, Chicago, Ill.; Carlyle M. Ashley, chief development engineer, Carrier Corporation, Syracuse, N. Y., and Hermann F. Spoehrer, vice-president and treasurer, Sporlan Valve Company, St. Louis, Mo., first, second vice-president, respectively.

M. M. Wilson, Mem. ASME, of the Baldwin-Hill Company, Trenton, N. J., was recently elected president and chairman of the board of the Industrial Mineral Fiber Institute, Inc., at its fourteenth annual meeting at Sea Island, Ga.

John D. Ryder, dean of the school of engineering, Michigan State College, East Lansing, Mich., was elected president of the Institute of Radio Engineers for 1955. Franz Tank, professor, Swiss Institute of Technology, Zurich, is IRE vice-president for 1955.

Robert E. Gross, president and board chairman, Lockheed Aircraft Corporation, Burbank Calif., has been elected president of the Institute of the Aeronautical Sciences for 1955. Other officers elected include four vice-presidents, who are: Roger W. Kahn, test pilot and service manager, Grumman Aircraft Engineering Corporation, Bethpage, L. I., N. Y.; T. Claude Ryan, president, Ryan Aeronautical Company, San Diego, Calif.; Edward R. Sharp, director, Lewis Flight Propulsion Laboratory, NACA, Cleveland, Ohio, and Edward C. Wells, vice-president—engineering, Boeing Airplane Company, Seattle, Wash.

Warren H. Brand, director of engineering and research, Conoflow Corporation, Philadelphia, Pa., was elected president of the Instrument Society of America, and A. A. Anderson

Assistant Secretary for Air James H. Smith, Jr., *right,* fastens Navy Distinguished Civilian Service Award button on William A. Zisman. Dr. Zisman is head of the Surface Chemistry Branch at the Naval Research Laboratory, Washington, D. C. The award was given for his advanced research in the field of lubrication. (*Official United States Navy Photograph.*)

and W. H. Fortney were named to the offices of vice-president for two-year terms. Mr. Anderson is owner and president of Swissomatic Products and several other Southern California firms and Mr. Fortney is assistant superintendent of maintenance and construction at the Humble Oil & Refining Company, Houston, Texas.

Allison C. Neff, vice-president of Armco Drainage & Metal Products, Inc., Middletown, Ohio, has been nominated as candidate for 1955 president of the National Society of Professional Engineers.

Samuel Morrison, president of Morrison Steel Products, Inc., Buffalo, N. Y., was elected president of the Pressed Metal Institute at its sixth annual meeting at Manoir Richelieu, Murray Bay, Quebec.

Engineers Expect New Atomic Data

Plans Made for a Meeting in Cleveland to Sift Facts Declassified by AEC

Plans for a major nuclear-engineering congress, at which a vast store of scientific information to be declassified by the Atomic Energy Commission will be made available, were disclosed at a meeting at the Engineers' Club, New York, N. Y., January 13.

The meeting will be held in Cleveland, Ohio, Dec. 12 to 17, 1955. It will be under the auspices of the Engineers Joint Council.

The "Nuclear Congress and Atomic Exposition" is planned, it was said, for the December date to place it as soon as possible after the international "Atoms-for-Peace" conference arranged by the United Nations late this summer in Geneva.

The United Nations conference will be a "closed meeting" at which only invited participants will attend. The time is not fixed yet. It is expected that the United States Atomic Energy Commission will feel free to declassify (remove from security restrictions) information presented at that meeting by American and foreign delegations.

Important Milestone Seen

According to Donald Katz, Mem. ASME, chairman of the program committee for the nuclear congress and chairman of the chemical and metallurgical-engineering departments at the University of Michigan, the Cleveland meeting should be "a very important milestone in the release of information" on the peaceful applications of nuclear energy.

John R. Dunning, Mem. ASME, chairman of the council's General Committee on Nuclear Engineering and Science and dean of engineering at Columbia University, said: "The expected declassifying of currently restricted information following the Geneva meetings will make possible open discussion and planning at the Cleveland Congress, looking toward wider-scale peaceful uses of atomic energy. Emphasis will be on industrial applications."

Cleveland Open Meeting

In contrast to the Geneva session, the Cleveland meeting will be open to all. According to present plans, about half the Cleveland program will be concerned with information just released by the AEC; the remainder will be reports that will be new, and never have been under security regulations.

Engineers Joint Council

The Engineers Joint Council is composed of a dozen scientific and engineering societies, including The American Society of Mechanical Engineers, with a total membership of 250,000 scientists, engineers, and industrialists. Brigadier General Stewart E. Reimel, Ret., is secretary of the Council, which has offices at 29 West 39th Street, New York, N. Y.

The Nuclear Congress and Atomic Exposition represents the biggest single project yet undertaken by the combined engineering and scientific societies of the nation. In addition to covering the interrelations of all branches of the nuclear sciences and engineering, both events have the active support of private enterprise and of government in the power and other atomic fields.

Basic objective of the Congress is to launch a continuing program of interchange of information on the developing applications of nuclear science by the engineer for vital national benefits involving industry, agriculture, medicine, and the public welfare.

ASME Co-Operates With Rutgers University and N. J. Industries to Close Gap Between Class and Practice

The Department of Engineering Administration in the Rutgers University college of engineering, in co-operation with The American Society of Mechanical Engineers and 25 New Jersey industries, has established a program aimed at providing co-ordinating engineers.

Some enterprising and farsighted engineers and engineering educators in New Jersey have set out to eliminate a trouble spot in their highly-developed professions.

The problem is the gap between classroom and practice for prospective engineering administrators, young men who someday may be responsible for co-ordinating the multiple engineering problems that exist today in almost every industry.

As industry grows more and more complex, the need for qualified engineers to analyze and co-ordinate the activities of research and design engineers, industrial engineers, maintenance engineers, and sales engineers, all working on the same product, becomes more and more urgent.

Rutgers students, as a result, now go into each of those 25 industries to wrestle first-hand with day-to-day engineering problems.

The unique program had its beginnings nearly a year ago when Jack E. Walters, Mem. ASME, came to Rutgers to take over the chairmanship of the newly-formed department of engineering administration.

The first thing Dr. Walters did was to visit ten New Jersey firms and inquire about their conception of engineering administration. In addition to expanding the professor's "education," those visits paved the way for setting up the co-ordinated university-industry project in his new curriculum.

At present, American Cyanamid Company, Chesebrough Manufacturing Company, De Laval Steam Turbine Company, Edison Foundation, John A. Roebling's Sons Company, RCA Laboratories, Standard Oil Development Company, and Walker-Turner Company, have provided completed case studies for the Rutgers students, and 17 other companies are working on cases in various stages of completion.

A case covering several current engineering problems is drawn up by a representative of each company, generally, either the vice-president in charge of engineering or the chief engineer and Dr. Walters.

The students taking the course in engineering administration receive a copy of each case and visit each company where they must work on one of the problems posed by the company engineers. Dr. Walters says this is the sort of theoretical-practical study that can help co-ordinate engineering education and industry and encourage better postcollege training for engineers in industry. These cases, he explained, will be used by the companies to assist in the training of graduates from other institutions.

The engineering-administration curriculum, like all other curriculums in the Rutgers college of engineering, is based on a common core of subjects comprising roughly two thirds of the undergraduate program. In addition, majors in this department are required to take courses in industrial engineering and administrative engineering, and may elect from advanced courses in civil, electrical, and mechanical engineering, to fill out the program.

The field course in engineering administration is designed to supply versatility and teamwork.

"If they (the industries) give us the right problems," Dr. Walters declares, "we should be able to give them men trained to do a good and thorough job with a minimum of post-college training."

. . . On the Other Hand

Eight top-ranking students in the Rutgers college of engineering are being encouraged to let their imaginations "run riot" in an honors project, designed to provide a challenge for exceptionally gifted students.

The goal of the project is the promotion of creative thinking. The vehicle being used by this year's honors group is the development of a new method for converting solar energy into electricity.

In one phase of the project, these outstanding young scholars, representing virtually every engineering field, are taking a course titled "Applied Imagination." They are being taught to unharness their minds from conventional thinking and come up with as-

many new engineering ideas as possible, even if many of them are impractical.

Elmer C. Easton, dean of the college of engineering and presiding director of this unusual academic adventure, describes it as a boon to creative thinking developed atop a firm base of engineering fact and know-how.

Nearly all college curriculums, he maintains, are essentially geared to meet the needs of the "average" student and provide especial help for the poor student while neglecting the "brilliant minority."

Mindful that it will be these relatively few brilliant youngsters who will plan and build tomorrow's world, Dean Easton and his colleagues decided it was high time to devote some time to their problems. The honors project for seniors, established at Rutgers last fall, is the result.

The dean said the students were asked to select some field for original investigation to get the project underway. Having chosen solar energy, each was assigned to investigate a specific phase of that ageless subject. This followed two weeks of thorough instruction in the proper use of library research and reference facilities.

The first of the twice-weekly meetings of the project group—eight students and five professors—has been devoted to the correlation of all the research material from reports presented by each student. Now, they are drawing up feasibility studies to consider each other's suggested solutions to the problem from economical, mechanical, electrical, and structural standpoints.

The next and last step in the project will be the application of the product of eight minds and unloosed imaginations to the actual construction of a working model for the conversion of solar energy into electricity.

Dean Easton handles the second session each week when applied imagination is taught. The purpose of the course is to encourage flights of fancy. As the dean put it: "Too many young men fear new ideas; they are afraid of possible failure and subsequent ridicule; and, consequently, their imaginations are dull and rusty. We hope to give those imaginations plenty of exercise and a free rein."

The dean said only a dozen students in the entire college of engineering qualified for participation in the project because of its extraordinarily high standards. And because of the hard work involved, only eight of those enrolled, he added.

The dean is serving as chairman of the project faculty which includes Mark B. Moore, Mem. ASME, associate professor of mechanical engineering; Louis A. Rosenthal, associate professor of electrical engineering, James J. Slade, Jr., professor of engineering mechanics; and Robert B. Sosman, visiting professor of ceramics.

Coming Meetings ...

Machine Design

New developments and opportunities for profit in machine design will be explored at the 12th annual machine-design conference to be held at the Cleveland Engineering Society, Monday, February 7.

All-day sessions will embrace seven areas of interest. These subjects, to be covered by nationally known authorities associated in the field, include: New materials, design for appearance, design for cost reduction in manufacturing, steps in solving a typical design problem, simplified drafting, increased profits through effective technical writing and speaking, and design for profit.

Complete program and registration information can be obtained from the Cleveland Engineering Society, 2136 East 19th St., Cleveland 15, Ohio.

Materials Handling

Current practices and new techniques in the field of materials handling will be discussed at the fifth annual materials-handling conference at Purdue University, February 17 and 18.

The topics which have been scheduled for the conference include: Modern methods of equipment selection and analysis; case studies in materials-handling operations (a panel discussion); materials-handling evaluation; plant layout—materials-handling relationships and standard-data applications in materials handling; scheduling and dispatching in intraplant materials handling; college-industry relations in materials handling; materials-handling safety; and automation and automatic materials handling.

The meeting will be sponsored by the department of general engineering and Adult Education Division of the university in cooperation with the Indianapolis chapter of the American Materials Handling Society.

College-Industry Conference

A College-Industry Conference sponsored by the Relations With Industry Division of the American Society for Engineering Education will be held in collaboration with the Iowa Engineering Society at its annual meeting in Des Moines, Iowa, on March 1 and 2, 1955.

The preliminary plans include a one-half day program dealing with current challenges to the engineering profession and, also, an invited banquet speaker. The purpose of the College-Industry Conference is to foster cooperation between industry and colleges of engineering. The discussions will be mutually beneficial to both groups as well as to members of the Iowa Engineering Society.

Education . . .

Technion Graduates Get American Training

Sixty-Eight graduates of Technion, Israel Institute of Technology, are now in the United States working in American industrial plants under the apprentice training program sponsored by the American Technion Society.

The program, launched several years ago, enables Technion graduates of high academic standing and some practical experience to receive the benefits of American know-how through on-the-job training with firms co-operating with the Technion Society. After a year of this work, for which they receive a regular wage, the trainees return to Israel, where their American experience is utilized to help Israel in her program of industrial development.

Among the prominent firms making this training available to Technion graduates are Radio Corporation of America, National Pneumatic Company, Conmar Products Corporation, Construction Aggregates Corporation, Hercules Powder Company, Barber-Greene Company, General Electric Company, Fairbanks, Morse & Company, and others.

The apprentice training program is directed by the Technological Committee of the American Technion Society, 1000 Fifth Avenue, New York 28, N. Y.

3-2 Plan

The University of Pennsylvania and Susquehanna University have established a joint five-year curriculum, enabling Susquehanna students to study engineering at the University of Pennsylvania.

The new program was announced by G. Morris Smith, president, Susquehanna University, Selinsgrove, Pa., and Gaylord P. Harnwell, president, University of Pennsylvania.

By taking general studies for three years at Susquehanna and engineering for two years at Pennsylvania, a qualified student can earn two degrees—bachelor of arts from Susquehanna, and bachelor of science in a particular field of engineering from Pennsylvania.

Under the plan, a student completing his third year at Susquehanna would transfer into the junior class at Pennsylvania, where he would study chemical, civil, electrical, mechanical, or metallurgical engineering.

Susquehanna University becomes the ninth institution to establish such a program with the University of Pennsylvania.

Servomechanisms

A Teaching laboratory in servomechanisms was established recently at the Thayer School of Engineering at Dartmouth College through the co-operative aid of the Diehl Manufacturing Company and a grant of $5000 from the Ford Motor Company.

The laboratory is designed to train young engineers in the design, construction, and operation of servomechanisms, or feed-back control systems. These are at the heart of a developing revolution in mass-production techniques in this country.

The new laboratory will be under the direction of Prof. Charles Kingsley, Jr., visiting professor from Massachusetts Institute of Technology.

Engineering Information

The first course ever to be offered in engineering-information sources and literature will be given by the Columbia University school of library service, during the regular summer session, July 5, 1955, through August 12.

Russell Shank, librarian of the Engineering and Physical Science Libraries at Columbia, will teach the course, which will survey and evaluate library resources in engineering and physical sciences. It is designed to meet problems of academic and industrial librarians.

It will also discuss methods of obtaining house organs, trade journals, memoranda from industrial corporations, press releases (and how to use them), industrial films, and mimeographed documents and reports on government-sponsored research by industry, universities, and government agencies.

The course will be held daily during the summer session. Three-points graduate credit in the Columbia School of Library Service will be offered. Tuition and registration fees are $82.

Industrial Management

Combinations of engineering courses with courses in business administration have been inaugurated at the Univeristy of Rochester, under a new interdepartmental program leading to the bachelor of science degree in industrial management.

The new curriculum is designed to train students for such industrial-management jobs as plant-personnel work, industrial safety, and purchasing.

Lewis D. Conta, Mem. ASME, chairman of the University of Rochester, division of engineering, believes that the establishment of the program will help to alleviate the current engineering shortage.

"The increasing complexity of industrial operations has resulted in an increasing use of engineers in nonengineering departments of industrial organizations," Dr. Conta noted.

"This arrangement has the undesirable effect of reducing the supply of engineers available for positions requiring their full training, and of supplying to the positions in borderline management areas men with more than the necessary technical ability, but who are inadequately prepared for the nonengineering aspects of their duties."

Under the new program, a student working for a degree in industrial management through the business administration-engineering program will take approximately 30-credit hours of study in the basic sciences, 40-credit hours in engineering, 30 in humanities and social sciences, and 36 in economics and business administration.

"The student will not be an engineer when he graduates," Dr. Conta said, "but he will have a thorough understanding of engineers and engineering problems."

He pointed out that the program set a middle-of-the-road course between industrial engineering, which is an engineering program with a small amount of business administration, and business administration, which provides for no engineering study.

It is expected that the new program will appeal to students who start engineering and later find that they are not interested in the highly technical aspects of the field, as well as to students who have an interest in industry but do not wish to practice engineering exclusively.

Research—Sun Stove

The Ford Foundation has made a grant of $45,000 to the Research Division of New York University's college of engineering for further development of a sun stove for cooking in underdeveloped areas in the tropics—principally in India and the Near East.

The project, which also will include economic and sociological studies to determine acceptability of the device, is to center on a solar stove, conceived and developed by Maria Telkes, research associate in NYU's Engineering Research Division.

Dr. Telkes—who has designed a house heated by the sun and evolved a solar still that enabled shipwrecked servicemen of World War II to obtain fresh water from salt water by sunlight—will direct technical aspects of the project.

Prof. Ethel Alpenfels, social anthropologist at NYU's school of education, will assemble and interpret information on customs and history of the areas where the stove may be used. Renato Contini, NYU's research co-ordinator, will have over-all supervision of the study.

Dr. Telkes and Professor Alpenfels will be assisted by research assistants, Hyman Steinberg and Fatoolah Sotoodeh. Mr. Steinberg, a graduate architectural engineer who has directed a study in the application of engineering and cost principles to the design and fabrication of homes, will work on design details of the stove. Mr. Sotoodeh, a graduate of the University of Teheran, who is studying for an advanced degree in NYU's college of engineering, will conduct some of the surveys of skills, materials, and production facilities in several of the areas of the world. The Division hopes to enlist in the work nationals from other countries that may use the stove.

NAM Reports

The National Association of Manufacturers recently published and distributed the findings of two studies on the financial problems of education. The reports were entitled: "Our Public Schools and Their Financial Support" and "Our Colleges and Universities and Their Financial Support."

Briefly, the reports emphasized these disturbing facts: The nation's educational facilities are not keeping pace with the growth in population or with the rise in our national income. Serious shortages of both teachers and classrooms exist—and the situation is getting worse. Enrollments are increasing far more rapidly than are funds for new schools, more teachers, and higher teacher salaries. Additional financial support must be provided to assure America's youth the education he must have to share in and contribute to a better future for all. If states, communities, and private individuals and organizations, fail to provide this needed support, the federal government will step in to provide the money. This would mean higher federal taxes and reduced local control of education. But, much more important, federal support would necessarily require federal control over the kinds and quality of education. Diversity would give way to uniformity.

Copies of the two reports are available on request from the Education Department of the National Association of Manufacturers, 2 East 48th St., New York 17, N. Y.

Scholarships and Fellowships

The National Open Hearth Committee of the American Institute of Mining and Metallurgical Engineers has established an annual scholarship in the department of metallurgy at Carnegie Institute of Technology in honor of Leo Reinartz.

The Leo F. Reinartz AIME NOHC Scholarship Award will be used to attract outstanding young men to the field of metallurgical engineering. A $15,000 fund was authorized to support the scholarship. Carnegie Institute of Technology will suggest candidates to receive an annual stipend of $500.

The first Leo Reinartz Scholarship will be awarded next spring and the award will be effective on Sept. 1, 1955.

Applications for the American Society of Tool Engineers' ten International Education Awards for outstanding engineering students in recognized schools in the United States and Canada are now available from deans of engineering schools and from the national ASTE headquarters at 10700 Puritan Avenue, Detroit 38, Mich.

Deadline for the filing of applications at the ASTE headquarters is Feb. 15, 1955.

Winners of the ten awards of $700 each will be announced during the annual meeting of the Society in Los Angeles, Calif., March 14 to 18, in conjunction with the first ASTE Western Industrial Exposition.

To be eligible for the awards which are effective at the beginning of the fall term of school in 1955, a student must be taking full-time courses in preparation for future work in tool and production engineering. He must be in his third year of a four-year curriculum or third or fourth year of a five-year curriculum or in the last year of study and planning to take postgraduate work.

A $4000 annual fellowship in nuclear engineering has been created at Case Institute of Technology, Cleveland, by General Dynamics Corporation.

The first fellowship will be awarded in February or March, 1955, and will become effective in the academic year, starting in September of that year.

Determination of the winner, who must be a Case graduate, will be made by the school's Committee on Graduate Study.

The fellowship will be known as the General Dynamics Fellowship in Nuclear Engineering and will furnish the winner with a $2500 stipend, plus payment of full-tuition fees. The balance of the sum will be retained by Case to cover additional expenses of the program of the fellowship's holder.

The winner of the fellowship must be a candidate for either a master's or a doctor's degree. The fellowship will ordinarily be for an academic year although in exceptional

(*Continued on page 199*)

Junior Forum . . .

Conducted by R. A. Cederberg,[1] Assoc. Mem. ASME

Pieces of Paper

Reported by Frank K. Bayless,[2] Assoc. Mem. ASME

An engineer's success depends on his accomplishments. His continued success may depend on his own personal record of these accomplishments.

Each engineer should keep a complete file which is a record of the work he has done in the engineering field, and he should be able to produce it when the need arises. What should this file contain—the various pieces of paper that he gathers as he goes through life achieving the goals which he sets for himself.

In a friendly argument with another young engineer recently, this point was brought strongly to mind. He argued that he himself had gone to considerable effort to acquire special skills of little-known mathematical techniques in order to be able to do his job better. This was sufficient in itself, he claimed.

The record would stand by itself for any future employer to see. It was unnecessary to have a file of accomplishments or to exert himself to gain additional outside achievements. I agreed that it is very important to acquire special and unusual skills, but I asked what evidence can the engineer give that he possesses these skills except his word, the boss's word, and perhaps a ream of hieroglyphics that very few persons understand. Obviously, his word is good but of limited value to a cold-eyed personnel man. Bosses die and move and forget. And the calculations mean little to anyone except to another similar expert—which the personnel man may not be. So, in my opinion, in addition to the acquiring of the highly specialized skills, it is desirable to have tangible pieces of paper to show our levels of accomplishment.

First Papers

The first of these which most of us get is an engineering degree. This is evidence of four years of work and study, and of having been exposed to the basic elements of engineering. It is the key to many doors, which the noncollege man finds locked, or at least obstructed.

There are other tangible evidences of education and accomplishment, the license for Professional Engineer being one. This is the license that a state grants an individual, permitting him to be responsible for engineering projects where state money is involved, and it is the highest state-granted evidence of engineering qualifications. The present requirement to qualify for this license in most states is a four-year engineering degree, four years of acceptable experience, and the passing of a stiff written examination, or for the noncollege man, eight years of experience and the same written examination. It is a piece of paper that every engineer who can qualify should have, in order to raise the professional standard to its highest level. Incidentally, if the examination is taken some time after graduation, it presents a fine opportunity for a complete review of all the engineering work, from the broad basic laws to specialized techniques. And until one has made such a review, it is difficult to visualize how useful it can be.

Advance by Degrees

Multiple degrees are another evidence of extended work or study. They demonstrate the broadening of education into other fields. And, certainly, an individual can claim an impressive background if his degrees encompass such fields as law and engineering, or business administration and engineering. Often these men advance over the specialist, because advancement brings with it the broadening in scope of the job and, consequently, the wider educational requirement.

Along the same line, and a little advanced from it, is the attainment of other pieces of paper such as attorney-at-law, patent attorney, or certified public accountant. These are all tangible evidences of accomplishment and, certainly, the one who holds them gets preferential treatment wherever he may go.

An advanced degree is a piece of paper proving an unusual amount of mental ability and perseverence, and frequently denotes a specialist. Certainly, fields such as physics and chemistry almost demand advanced degrees in order to qualify for the work at all. Other fields such as sales have limited use for advanced work and the man who enters this field finds he could have used his time better in acquiring industrial experience.

Patents

A patent is another piece of paper demonstrating that the inventor had a new and novel idea—and ideas are the bread and butter of our profession. And of course, the feeling always exists that if a man had one patentable idea, he may well have another, or several more, if he is placed in a stimulating atmosphere.

Perhaps, the most concrete evidence of the desirability of these patents, as far as personal advancement is concerned, is the fact that one is always asked about them in any application for employment. Certainly, I do not mean to overlook the primary benefits of patents: The possibility of royalties or the protection of a unique idea from being copied by an unauthorized person, or even the personal satisfaction of obtaining a patent. The question is often asked—why try to get a patent when it will be assigned to the company? Granted this fact, the inventor is still the inventor, and he is the one who forever afterward can accept the credit for the basic idea.

Technical-Society Affiliation

Membership in a technical society provides a piece of paper which may indicate a high level of qualification. Certainly, a Fellow in the ASME would have an edge over a nonmember of equal age and years of experience because he has ready proof of his contributions to engineering over the years. Primarily membership and participation in technical societies provide a means of contact and communication that all engineers need in these times of rapid technological advancement. Therefore membership tends to point to the well-rounded and versatile engineer.

Engineering-application forms have space for listing publications and oral presentations. Executives responsible for hiring and for advancement take note of this for a good reason: An engineer with the initiative and concentration to write articles or to prepare speeches shows interest and perseverance which make him valuable to his company. The research necessary in accumulating data for such presentations is, to the personnel executive, an indication of character, ability, and initiative, which is most valuable.

An engineer should devote himself to his job in order to learn all he can about it. This devotion will better qualify him for his present position, and in time lead to advancement. Finally, every engineer should make the additional effort to accumulate various pieces of paper, so that he will have tangible proof of his ability and qualifications.

. . . . Chairman's Corner

We want you to feel that the Junior Committee is your voice—and it is. We will keep alert to your murmurings which, at times, are hardly audible. We do know that you have something to say. We are listing the new officers of the Junior Committee, any one of whom would be happy to receive any constructive suggestions or ideas that you may have.

Or perhaps, you would prefer talking with a corresponding member who lives near you. If you don't know who they are contact us and we will let you know.

1955 Officers

Chairman: C. T. Miller, Engineering Division, Curtiss-Wright Corporation, Wright Aero Division, Woodridge, N. J.

Vice-Chairman: Joseph Schmerler, 29 West 69th Street, New York 23, N. Y.

Secretary: W. R. Thompson, 7326 Germantown Avenue, Philadelphia 19, Pa.

[1] Westinghouse Electric Corporation, Pittsburgh, Pa.

[2] Vacuum-Cleaner Department, General Electric Company, Cleveland, Ohio. Assoc. Mem. ASME.

Education *(continued from page 197)*

circumstances it may be extended for another half year.

Early this year General Dynamics inaugurated a scholarship program for the sons of employees at its Electric Boat Division, Groton, Conn., and its Electro Dynamic Division, Bayonne, N. J. This program furnishes an undergraduate four-year scholarship for youths interested in a technical education leading to a bachelor of science degree.

A Program of financial aids for students who will study for advanced degrees in the School of Industrial Management at the Massachusetts Institute of Technology during 1955–1956 was announced by E. P. Brooks, dean of the school.

Assistantships and fellowships, Dean Brooks announced, will be available to a number of students in the two-year course which leads to the degree of master of science in industrial management. This educational program, he said, is planned as preparation "for effective and imaginative leadership in the field of industrial enterprise."

The program is especially intended, Dean Brooks points out, for college graduates in fields of science or engineering. Assistantships, with a stipend of $1640 for each academic year, are available to certain men with an educational background which permits them to carry a reduced-course load. For these assistants the tuition is $540.

Fellowships to enable a number of students of unusual ability to attend the school are available each year. These fellowships typically provide full tuition as a minimum and range upward to $3000 for married men or $2300 for those unmarried.

In both cases applications should if possible be filed before March 1, 1955.

Further information about the school and about this program of financial aids may be obtained from the Chairman of the Graduate Committee at the School of Industrial Management, Massachusetts Institute of Technology, Cambridge 39, Mass.

An Engineering curriculum of graduate study and fundamental research in plastics leading to the degree of master of science in engineering, particularly suited to chemical, electrical, and mechanical engineers, and to chemists and physicists, is offered in the graduate program at Princeton University.

Instruction covers properties, evaluation, production, fabrication, design and application of materials, as well as chemistry of plastics. Program includes lecture and laboratory classes, and contact with industrial plants representing various interests of the plastics industry.

Fellowships with stipends of from $1500 to $2100 plus tuition and fees are available. Opportunities for employment as half-time research assistants at $1500 per academic year are also available to students not on fellowships.

Applicants for admission must hold a bachelor's degree in engineering or physical science from a recognized institution and must meet general admission requirements of the Graduate School of Princeton University.

For further information regarding curriculum, fellowships, research assistantships, and application forms, address: Louis F. Rahm, *director*, Plastics Laboratory, 30 Charlton Street, Princeton, N. J.

Carnegie Institute of Technology offers opportunities for advanced study and research leading to MS and PhD degrees in the following fields: Chemistry; chemical, civil, electrical, metallurgical, and mechanical engineering; mathematics, and physics. Graduate study and research in the college of engineering and sciences announced that teaching assistantships, graduate fellowships, and research assistantships for the academic year 1955–1956 were available.

Requirements for advanced degrees, graduate courses, and opportunities in research offered by the various departments are described in the Bulletin of Graduate Study in Engineering and Science, which is available upon request.

The Institute will consider applications from qualified students who wish to begin or return to graduate study in the fall of 1955. Applications for admission to graduate study and for assistantships or fellowships, together with transcripts of record and other supporting evidence, should be submitted as early as possible, preferably not later than March 1, 1955. However, applications from able and well-qualified candidates will be considered if received at a later date. Address all inquiries to: Dean of Graduate Studies, Carnegie Institute of Technology, Pittsburgh 13, Pa.

G. E. Aid to Schools to Exceed $1 Million

The General Electric Company said it would give "substantially more" than $1 million to educational institutions in the 1955-1956 academic year to help alleviate the "critical shortage of professional manpower throughout the nation."

Last year the company gave $800,000 to colleges and universities through its Educational and Charitable Fund, according to Kenneth G. Patrick, manager of the Department of Educational Relations Services.

The bulk of the new awards, he said, would be in the fields of physical science, engineering, and industrial management, although some would be offered in the arts, law, and business.

Mr. Patrick said that the fund, which made 31 grants totaling $97,400 for postgraduate fellowships last year, would award 74 grants totaling $250,000 for the academic year beginning next fall.

Moreover, the fund will finance 170 undergraduate scholarships and 200 "summer-school" fellowships in science and mathematics. Allotments will be made to several institutions for scientific equipment.

The fund also will administer G. E.'s recently announced plan of matching contributions made by employees to educational institutions, Mr. Patrick said.

ASME Council Actions on 1954 National Agenda Reported

How the National Agenda Is Compiled for Regional Administrative Committees and Items Which Are Ultimately Acted on by Regional Delegates Conference

The American Society of Mechanical Engineers has developed a procedure whereby action is taken by all Sections on suggestions made by any Section to improve policies, procedures, and operations of the Society. This procedure starts with the compilation by the National Agenda Committee of preliminary statements of the items suggested. If 15 Sections approve any one item, it is included in a National Agenda for discussion at Regional Administrative Committee meetings held in the spring. Further discussion at a national level takes place at the Regional Delegates Conference held during the Semi-Annual Meeting. The results of this Conference are then submitted to the Council.

The principal business of the Regional Delegates Conference held during the Semi-Annual Meeting is to consolidate the actions of the eight RAC meetings on the National Agenda and to report the consolidated view to the Council. Related matters frequently arise on which a consolidated view is developed or on occasion the Council may request the opinion of the RDC on a Society policy or procedure. The Council is usually in session at the same time as the RDC and provision is made for the Delegates to attend the Council Meeting.

A report of the principal actions of the Conference is made to Council for information at the Council Meeting during the current Semi-Annual Meeting. The Council studies the full set of final minutes when prepared, referring to the various administrative agencies of the Society the different items with which those agencies are concerned.

The actions of Council on the Recommendations of the RDC are reported to the Delegates and to the Section Executive Committees before the next RAC meetings. Thus the cycle from origination of items by the Sections to action by Council is completed within one year.

Compilation of the National Agenda

About September 15th of each year the chairman of the Agenda Committee sends forms to the Sections and requests the submission of items by October 31.

Upon receipt of the items, the Agenda Committee reviews them, corresponds with the

suggesting Section, and refers the items that can be dealt with promptly, as administrative matters, to the proper administrative agency.

About January 1 a compilation of all items passed by the committee is sent to the Sections for an expression of opinion as to inclusion in the final agenda. By the end of February the Agenda chairman must have all the opinions. Fifteen Sections must approve an item before it can become a part of the National Agenda, which is sent out to all the Sections at least three weeks in advance of the first RAC meeting.

Action in the Sections

The National Agenda requires action in the Section Executive Committee on at least three points.

A In the original suggestion of items. In this process it is desirable to canvass member opinion by some method, by mail, or at a Section meeting.

B The expression of opinion about including an item in the National Agenda.

C A determination of the position the Section is to take on the items in the National Agenda.

It is generally desirable for the Section to select its representatives to the RAC meeting at an early date so that they may be in touch with the entire process of developing the National Agenda.

Copies of this report are available by writing to the Secretary, ASME, 29 West 39th Street, New York 18, N. Y.

A summary of actions by the Council on recommendations of the 1954 regional delegates conference (Pittsburgh, Pa.) follows:

Final Report

Agenda Topic No. 8: Life Membership be granted to any member who has paid for 35 years or who has reached the age of 65, whichever occurs first, providing he has paid dues for a minimum of 25 years.

Delegates' Action: CARRIED 11 to 1

Council Action: Serious difference of opinion about this recommendation has arisen in the Committees concerned with the problem. Fact determinations are required. Action by the Council in January or February is expected.

Agenda Topic No. 59 A: Progress in Forming Unity Organization for the Engineering Profession Be Reviewed and Discussed.

It is proposed in regard to the program being carried out to form a Unity Organization for the Engineering Profession that:

1 Sections be provided with a current progress report on the subject at least 30 days prior to the Regional Administrative Committee meetings.

2 The matter be discussed at the RAC meetings and the Delegates to the Regional Delegates Conference be prepared to present the views of their Regions.

3 At the Regional Delegates Conference, one of the Society's representatives to EJC reports on the progress to date and outlines any anticipated courses of action.

Delegates' Action: APPROVED 14 to 0

Council Action: The Council welcomes the interest of the officers of the Sections in problems related to the organization of the engineering profession, approves the program recommended by the Regional Delegates Conference, requests the co-operation of ASME representatives to Engineers Joint Council in carrying out the program, and instructs the Secretary to co-ordinate the efforts necessary to carry it out.

Agenda Topic No. 19 A: It is proposed that a Committee be appointed to study all aspects of the initiation fee and its effects upon membership and/or membership development and cost to the Society. This study is to include the selection of the most advantageous method of initiation-fee payment to all concerned.

Delegates' Action: CARRIED 12 to 2

Council Action: The Council appoints the following committee to make the study suggested by the Regional Delegates Conference and report to the Council before May 20, 1955:

Chairman, Board on Membership
Chairman, Membership Development Committee
Representative of Finance Committee, selected by the Finance Committee
A Vice-President, appointed by the President
A director, appointed by the President

Agenda Topic No. 24: The Secretary's office shall continue the practice of sending through the Section officers in January of each year the bills for those members who owe two years' dues and who, therefore, are to be dropped on March 1.

Delegates' Action: CARRIED 9 to 3

Council Action: The Secretary's office will follow the recommendation of the Regional Delegates Conference.

Agenda Topic No. 33: The section of MECHANICAL ENGINEERING entitled "Briefing the Record" be expanded to become a more important part of the magazine.

Delegates' Action: CARRIED 12 to 0

Council Action: The Council concurs in the desirability of expanding "Briefing the Record" within budgetary limits.

Agenda Topic No. 45: The Publications Committee and the Machine Design Division consider the publications of more aids to the design engineer such as, Design Data, Applied Mechanics Books One and Two.

Delegates' Action: CARRIED 13 to 0

Council Action: More aids to the design engineer are under development by the Machine Design Division.

Agenda Topic No. 51: A policy be formulated and stated concerning the part that a Section plays relative to the costs of, and profits from, National or Professional Division Meetings held within the confines of the Section.

Delegates' Action: CARRIED 12 to 1

Council Action: A statement of policy approved by the ASME Board on Technology will be included in the proper manuals and transmitted to the Sections by the Vice-Presidents.

Agenda Topic No. 56: The Society take steps to place greater emphasis among Student Members and Associate Members who are recent graduates toward maintaining and strengthening our professional attitudes.

Delegates' Action: CARRIED 9 to 4

Council Action: The National Junior Committee is conducting an active program to strengthen the professional attitude of recent graduates who have become Associate Members. Inspiring literature is distributed to Students who are about to graduate. The Honorary Chairmen of Student Branches are alert to the problem. The close liaison between Sections and nearby Student Branches will help. The Vice-Presidents are asked to suggest further specific steps to be taken.

Agenda Topic No. 57: The Society implements its public-relations activities in order to better acquaint high-school teachers and high-school students with the qualifications required for studying engineering and with the opportunities available to engineering graduates so that more qualified people may enter the engineering profession in the coming years.

Delegates' Action: CARRIED 9 to 2

Council Action: See action on Alternate Item 57.

Agenda Topic No. 57 A: It is proposed that the Regional Vice-Presidents of the Society be requested to induce the Sections in their Regions to increase to the utmost their activities promoting engineering education, in order to better acquaint high-school teachers and high-school students with the qualifications required for studying engineering and with the opportunities available to engineering graduates, so that more qualified people may enter the engineering profession in the coming years.

Delegates' Action: CARRIED 11 to 2

Council Action: The relations with high-school teachers and students must be developed by the members in their own communities. Some suggestions can come from a central agency as they have come from Engineers' Council for Professional Development and Engineering Manpower Commission. The Council requests the Vice-Presidents to inaugurate a vigorous program to inform the officers of the Sections about the national programs under way and organize the efforts of the Sections to carry out an active ASME program.

New Business

Agenda Topic: It is proposed that the Region V Professional Divisions Liaison Committee Report be brought to the attention of the RDC as a matter of new business; that the report of the Region V Committee be included in the Minutes of the RDC, and that Council be requested to consider the suggestions contained in the report, particularly that a Professional Interests Committee of a permanent and continuing nature be established at the

Region level. [Copy of the Report referred to is available on request.—Editor.]

Delegates' Action: CARRIED 14 to 0

Council Action: The Board on Technology believes that discussion of professional interests at the Regional Administrative Committee meetings is desirable. Whether a formal committee organization is necessary should be determined by the Vice-President in each Region.

Change in EJC Constitution: At the request of Council for RDC reaction to the proposed changes in the Constitution of EJC involving the addition of enabling clauses to permit the election of Associates, the admission of affiliates and individual members to EJC, the following motion resulted after considerable discussion:

Motion by D. A. Holden, seconded by G. M. Ketchum, that the RDC express to Council that it favors EJC's proposal to admit Associate Societies and Affiliate Organizations as explained to this body and also that we express no opinion on the question of individual membership in EJC.

Motion carried 12 to 1

Council Action: The Council at Pittsburgh, Pa., June 20-21, 1954, voted to approve changes in the Constitution of Engineers Joint Council to permit small national societies to join as associates; local societies and federations to join as affiliates; and individuals to have membership status. Sufficient other societies approved the associate and affiliate membership so that EJC constitution was changed in these two respects. Three societies opposed individual membership.

Agenda Topic A31-33: It is proposed that we express our commendations for the changes recently made in the format of MECHANICAL ENGINEERING and urge that the work toward improvement of the magazine be continued by adding to the art and editorial staffs as may be found warranted and also by the expanding of popular sections such as "Briefing the Record."

Delegates' Action: CARRIED 11 to 2

Council Action: The Council notes with pleasure the commendation on the improved appearance of MECHANICAL ENGINEERING and in turn commends those responsible and encourages additional improvement as feasible.

1955 Agenda Committee

Motion: That the 1954 Regional Delegates Conference request the *1955 Agenda Committee* to do the following:

1 Prepare and distribute to the Sections a set of suggestions on how to write Agenda items so they will contain a definite proposal in a form suitable for simple rejection or approval action.

2 Analyze Agenda items submitted for ambiguous and unsuitable form and refer those considered defective back to the writer with suggestions for improvement. It is recognized that, if the writer insists, the committee must accept the item as written.

3 Include on the instruction sheet attached to the Agenda prepared or the Regional Administrative Committee Meetings the request that if an item is, in the opinion of the committees, unsuitable for intelligent action by simple approval or rejection, the committee submit a motion of its own stating its views on the item.

4 Include on the instruction sheet attached to the Agenda prepared for the Regional Delegates Conference a similar request to that contained in Item 3 afore-mentioned.

5 Include in the Agenda prepared for the Regional Delegates Conference the special actions taken by the Regional Administrative Committees under Item 3 afore-mentioned as well as their votes of approval or rejection.

6 Add to the afore-mentioned any measures which they believe will further expedite the preparation and processing of the Agenda.

7 Report to the 1955 Regional Delegates Conference upon their success with this plan as a guide for action of future Agenda committees.

8 Report to 1955 RDC action of Council on Agenda Items passed by the 1954 RDC.

9 Maintain and keep up to date Index and Record established by 1952 Agenda Committee, and provide for more effective utilization of this Index by the Societies.

10 To consider only those Agenda items that are approved by a Section, Division, or a recognized national activity.

Delegates' Action: CARRIED UNANIMOUSLY

This does not require Council action—requires attention of 1955 Agenda Committee.

Items Rejected

To complete the record, the following items that appeared on the original Agenda for the Regional Administrative Committee meetings were rejected:

No. 13—Index 17.41; No. 19—Index 15.17; No. 47—Index 12.57; No. 49—Index 10.24; No. 53—Index 19.131; Alternate No. 53; No. 55—Index 22.31; No. 58—Index 10.811; and Alternate No. 59.

Actions of the ASME Executive Committee

At a Meeting at Headquarters, Dec. 22, 1954

THE first meeting of the 1955 Executive Committee of the Council was held in the rooms of the Society on Dec. 22, 1954. David W. R. Morgan, chairman, presided. In addition to Mr. Morgan there were present: F. L. Bradley, Thompson Chandler, A. C. Pasini, and W. F. Thompson of the Executive Committee; L. N. Rowley, Jr., chairman, Finance Committee; J. L. Kopf, treasurer; E. J. Kates, assistant treasurer; H. C. R. Carlson, J. H. Davis, and Joseph Pope, directors; C. E. Davies, secretary; O. B. Schier, 2nd, assistant secretary; T. A. Marshall, Jr., assistant secretary; and Ernest Hartford, consultant.

ASME Faculty Adviser

At a recent vice-president's meeting it was suggested that the designation "Honorary Chairman" of an ASME Student Branch be changed to "ASME Faculty Adviser." The Executive Committee approved the recommendation and voted to secure preliminary approval by the Council, in advance of the June, 1955, meeting, of an amendment to Article R12, Rule 1, which this change necessitates.

Air-Pollution Controls Committee

An appropriation of $8000 was voted for the 1954–1955 budget of the Air-Pollution Controls Committee.

Applied Mechanics Reviews

The Secretary reported that support for *Applied Mechanics Reviews* would be forthcoming from the National Science Foundation.

Certificates of Award

Certificates of award were granted to the following retiring chairmen of standing committees: E. B. Ricketts, Admissions Committee; G. R. Cowing, Board on Education and Professional Status; D. W. R. Morgan, Civic Affairs Committee; R. A. Seaton, Engineers Registration Committee; G. R. Hahn, Membership Development Committee; C. A. Hescheles, Membership Review Committee; V. W. Smith, Organization Committee; T. F. Perkinson, Professional Divisions Committee; P. T. Norton, Jr., Publications Committee; and W. P. Kliment, Standardization Committee.

The following retiring chairmen of Sections also were granted certificates: G. H. Frost, Central Iowa; B. H. Garcia, Jr., Central Pennsylvania; E. F. Obert, Chicago; G. H. Larkin, Cincinnati; C. R. Sutherland, Cleveland; Guerard Mackay, Delaware; L. E. Parks, Greenville; Emory Kemler, Minnesota; J. G. Floden, Rock River Valley; C. A. Hathaway, Waterbury; and L. D. Jennings, Youngstown.

Others awarded certificates included: A. W. Colwell, who served as chairman of the Milwaukee Section in 1952–1953, and P. L. Houser, retiring chairman of Sectional Committee B5, Small Tools and Machine Tool Elements.

1954 Power Show

The Secretary reported that a check for $14,000 had been received from the International Exposition Company in connection with the 1954 Power Show in Philadelphia, Pa. The Committee authorized crediting the sum to the Research Reserve.

Seventy-Fifth Anniversary

Mr. Marshall reported that the first steps had been taken on the preparation of a motion picture "to explain the role of mechanical

engineering in the development of our country" previously authorized by the Executive Committee.

The Committee requested further progress reports.

Appointments

The Committee assigned directors to the Boards and Committees of the Society as follows:

E. O. Bergman and Louis Polk, Board on Codes and Standards; R. L. Goetzenberger, Board on Education and Professional Status; H. C. R. Carlson, Board on Honors; H. C. R. Carlson, Board on Membership; R. L. Goetzenberger, Board on Public Affairs; J. H. Davis, G. A. Hawkins, R. B. Lea, and A. C. Pasini, Board on Technology; Joseph Pope and H. R. Kessler, Finance Committee; and F. L. Bradley and C. B. Peck, Organization Committee.

Reduction of Initiation Fee

The 1954 Regional Delegates Conference recommended that a committee be appointed "to study all aspects of the initiation fee and its effects upon membership and/or membership development and cost to the Society." The Committee voted to appoint the following Committee on Study of Reduction of Initiation Fees: W. H. Larkin, chairman, Board on Membership; J. D. Carr, chairman, Membership Development Committee; H. E. Martin, Finance Committee; W. H. Byrne, vice-president; and Joseph Pope, director.

Committee Appointments

The Committee voted to approve certain appointments on Committees. (ASME Annual AC-10, Personnel of Council, Boards, and Committees to be issued shortly will contain a complete list of all appointments.—Editor.)

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members, or nonmembers and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	84 East Randolph St.	100 Farnsworth Ave.	57 Post St.

Men Available[1]

Mechanical Engineer, 25 years' experience, diversified and specialized, electromechanical devices—controls, instruments; complex, intricate mechanisms, and special-process machinery; consultant. Desires responsible position at staff level, liaison, administrative, design, and production. Me-172.

Mechanical Engineer, registered; heavy machine-design and manufacturing experience with responsible charge of engineering and drafting department. Also diversified experience in the consulting field, with some research and development. Me-173-40-Chicago.

Works Manager, vice-president—manufacturing, 39; ten years' top experience as plant superintendent and works manager of a nationally known manufacturer of high-grade power-plant and industrial items. Experience includes foundry, precision light, and medium machining; and assembly operations; industrial-engineering and labor relations. Me-174-58-Chicago.

Sales Manager, textile-engineering graduate. Sales, administrative, and manufacturing experience in textile industry; successful sales record resulting from contact with engineering, research, and executive personnel. Me-175-59-Chicago.

Mechanical Engineer, 30, married; registered in Minn.; experienced in management, operation, manufacturing, costs, and sales. Desires permanent position in Midwest or West. Me-176-60-Chicago.

Mechanical Engineer, 28; BSME; two years' experience co-ordinating expansion of turbine-laboratory facilities, specification and report writing; three years' experience as supervisor drop-forge; one and one-half years' experience in manufacture power-plant equipment. Desires domestic or foreign employment. Me-177-37-Chicago.

Sales Engineer, 30; BSME; eight years' engineering and sales experience, electrical with OEMS, distributors, etc., in New England; can handle electrical or mechanical products anywhere. Me-178.

Sales Engineer, ScBME, MBA, Brown; 29, married; five years' experience sales, customer relations, production, plant engineering, machine design in industrial and utility fields. Desires sales and development toward executive management. Me-179.

Mechanical-Industrial Engineer, MBA; 32; eight years' experience in manufacturing engineering, production supervision, and product engineering in machinery field. Desires position in production or manufacturing engineering. Prefers eastern U. S. Me-180.

[1] All men listed hold some form of ASME membership.

Positions Available

Production-Planning and Control Supervisor, industrial or mechanical-engineering graduate, at least two years' manufacturing experience covering wooden furniture, springs, and metal products. $6000. N. J. metropolitan area. W-815.

Chief Draftsman, machine-design experience covering boring mills, lathes, gearing, presses, etc., to design automatic electric-welding equipment. $8000-$9000. Ill. W-817.

Consultant, graduate mechanical, 35-50, ten to 15 years' experience in plant engineering, including operations and maintenance, will provide counsel, advice, and appraisals on companywide basis; collect, co-ordinate, appraise, and exchange information regarding rates, costs, methods, and prepare manuals of recommended practices, in connection with the operation and maintenance of all utilities, heating, ventilating, air conditioning, etc. $10,000-$12,000. N. Y. State. W-822.

Engineers. (a) Mechanical designer, experience in thermodynamics particularly refrigeration in test and stratosphere-test chambers. Salary open. (b) Junior engineer, one or two years' experience in the field or just out of college with major in mathematics and good aptitude for drafting-room work. Salary open. Conn. W-828.

Engineers. (a) Rating engineer, mechanical graduate, specification and application experience covering heat exchangers for power and process industries. $6000-$8000. (b) Junior mechanical engineer, experience in heat-transfer field to prepare specifications and quotations covering heat exchangers and allied equipment. $5000-$6000. New York, N. Y. W-829.

Design Engineer, mechanical graduate, at least five years' design and development experience covering machinery and equipment for redesign and improvement of large laundry washers. $8000. Brooklyn, N. Y. W-830.

Manager of Engineering Department, must be graduate mechanical, chemical, or mining engineer. Must have ten years' solid experience as administrator, as well as technical experience in heavy chemical manufacturing. To $15,000. Midwest. W-831(b).

Design Engineer, mechanical graduate, 30-45, minimum of five years' experience in the design and/or operation of public-utility steam-power stations. Western Pa. W-832.

Chief Product Engineer, 35-45, to investigate new product development on precision mechanical, hydraulic, and electronic gadgets, as used in the aircraft industry. Must be able to do research, evaluate, know markets, and costs. $12,000-$15,000. East. W-834.

Sales Engineer, mechanical, chemical, or industrial graduate, sales and sales-promotion experience, preferably with refrigeration wholesalers and their customers, or refrigeration, air-conditioning, and maintenance problems. Travel in established territory necessary to maintain active wholesale accounts. Products are accepted as leaders in their field. $6000-$8000, expenses paid, incentive plan, plus other benefits. Texas. W-841.

Design and Development Engineer, mechanical graduate, 25-28, industrial-equipment and chemical-process experience for film manufacturer. $5000. New York, N. Y. W-844.

Research or Design Engineer, mechanical graduate, three to five years' experience in pneumatics, or in the design and testing of compressed-air devices. Experience in sliding-van-type mechanisms, such as air motors or internal-combustion machines, either automotive or aeronautical is ideal. $7200-$8400. Upper N. Y. State. W-853(a).

Senior Project Engineer, BS in mechanical, electrical, or electronic engineering. Must have six or more years' experience in electromechanical component project for test, design, liaison, and development work. Northern N. J. W-861.

Test Engineer, mechanical or metallurgical engineer, to follow through on the mechanics, which will involve the evaluation of different high-temperature alloys at temperatures between 1150 and 1500 F. Tests to be conducted six months in Md.; six months in W. Va.; six months in Ind. $6000-$8400. W-864.

Design Engineer and Process Engineer, mechanical graduates, some knowledge or familiarity with plastics: (a) Design of equipment; (b) process and process codes for production. No extensive experience required. Salaries open. Md. W-878.

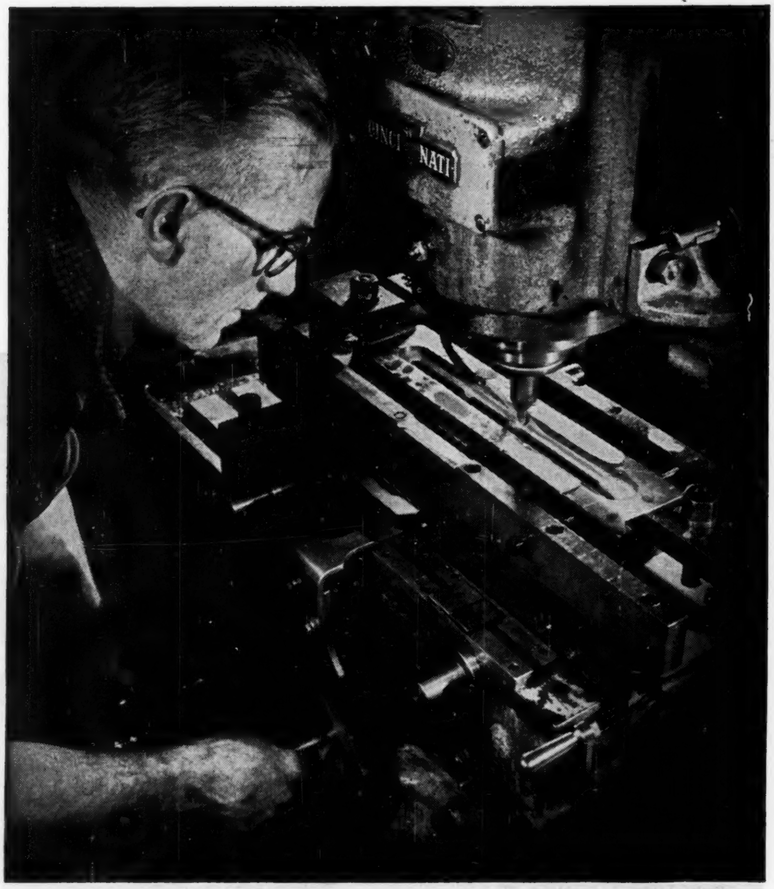
Engineering Personnel, theoretical and applied physicists, chemical, mechanical, and metallurgical engineers; recent graduates with BS degrees or with master's or doctor's degrees, with specialization in nuclear-reactor technology. Salaries open. U. S. citizen. N. Y. metropolitan area. W-887.

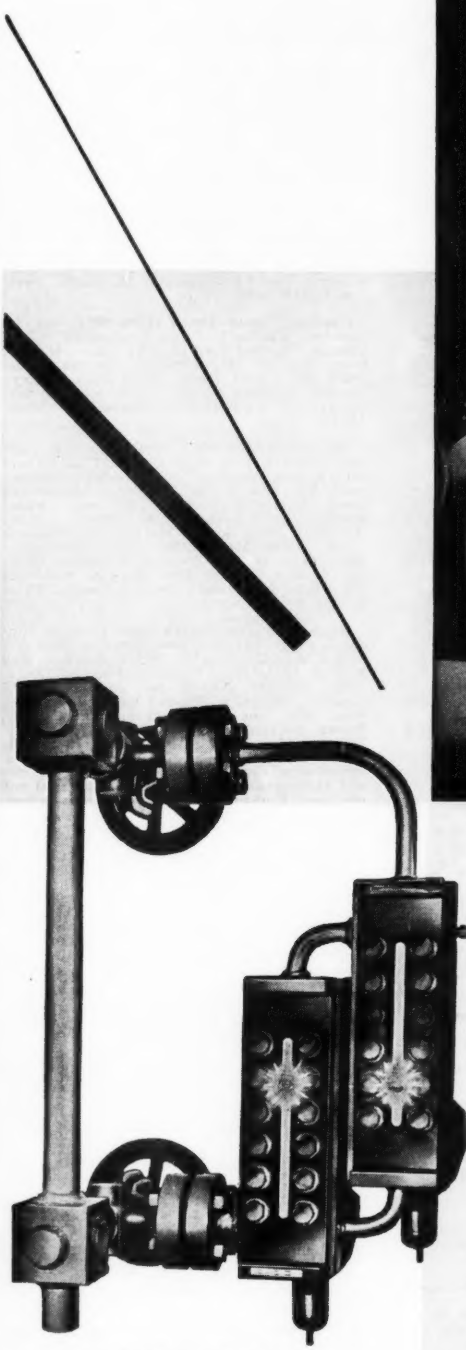
Sales Engineer, 30-40, electrical or mechanical graduate, sales experience contacting government agencies on fire-control and navigational systems. U. S. citizen. Considerable traveling. $8000-$10,000. Long Island, N. Y. W-891.

Chief Engineer, mechanical graduate, at least ten years' design and supervisory experience in special and textile-machinery fields, including chain-stitch equipment. Southern Germany. F-892.

Design Draftsman, preferably mechanical graduate, four to six years' experience covering design and layout of materials-handling facilities

(*ASME News continued on page 204*)





Yarway High Pressure Boiler Water Gage with separated-design flat glass inserts. Write for Yarway Bulletin WG-1812.

for cement mills. $6900. New York, N. Y. W-893.

Process-Methods Engineer, mechanical or electrical graduate, up to 47, at least five years' experience in methods and processing work, manufacturing, and assembling electronic equipment. Will process electronic equipment through manufacturing; some parts manufactured and some parts assembled; machine shop, sheet-metal shop, and bench assembly. $7000–$12,000. Employer will pay fee. Mich. C-2450.

Hydraulics-Design Engineer, mechanical, civil, or hydraulic graduate, 25–35, three or more years' experience in mechanical-hydraulic application or development work; knowledge of lift trucks helpful. Will design; experimental and contact work with suppliers. $6000–$6600. Employer will pay fee. Chicago, Ill. C-2453.

Sales Trainee—Contractors Equipment, 30–35. Design, application, or some sales experience, desirable in heavy contractors equipment. One to two years' training program to sell heavy equipment used by contractors and sold through distributors. Training in Chicago and then assigned to territory any place in U. S. for a shovel manufacturer. $4800–$5400. Car required. Chicago, Ill. C-2454.

Foundry General Foreman, 28–50, two or more years' experience in supervision of a nonferrous foundry. Must be well-versed in handling aluminum, brass, bronze, copper, lead, monel, nickel, zinc, and related alloys. Metals poured in sand and aluminum-permanent molds. Aircraft quality castings are x-ray inspected; automobile castings are polished and buffed to high finishes. Castings must be made in most economical manner by unskilled labor for competitive market. Must be able to plan and control production. $6000–$7800. Ohio. C-2472.

Candidates for Membership and Transfer in the ASME

The application of each of the candidates listed below is to be voted on after Feb. 25, 1955, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

Key to Abbreviation

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member

New Applications

For Member, Associate Member, or Affiliate

Abbott, Robert E., New York, N. Y.
Abraham, Edward D., Columbus, Ohio
Aichinger, Harry H., Toronto, Ont., Can.
Aikman, Alexander R., Ridgefield, Conn.
Anderson, John B., New York, N. Y.
Anderson, Reed M., Glenolden, Pa.
Auchmoody, Luther H., Scotia, N. Y.
Baron, Seymour, Bronx, N. Y.
Bergeron, Gaston P., Norco, La.
Bingham, James J., Washington, D. C.
Bonner, Harry E., Downers Grove, Ill.
Boyd, James E., Richland, Wash.
Bradley, John J., Hingham, Mass.
Brass, William C., New York, N. Y.
Bridgwater, Malcolm M., Prescott, Ariz.
Buehl, Ralph L., Hamilton, Ohio
Chang, Daval Y., New York, N. Y.
Chatterjee, Kali M., Washington, D. C.
Cho-Ying, Hui, London, England
Chou, Pei Chi, Philadelphia, Pa.
Clisset, Harold C., Levittown, N. Y.
Coleman, John D., Elmhurst, Ill.
Crandall, Stephen H., Cambridge, Mass.
Cronan, Calvin S., Old Greenwich, Conn.
Dassler, Albert L., Milwaukee, Wis.
Devrishian, Allen, Clifton, N. J.
Diederich, Alfred L., Norberth, Pa.
Dirkes, William E., Dayton, Ohio
DuBois, J. Harry, Montclair, N. J.
Dunn, Donald J., Providence, R. I.
Eiserman, Gert, Fishkill, N. Y.
Ekblade, Theodore C., Hamden, Conn.
Evans, James A., Birmingham, Ala.
Foster, Harold L., Overland Park, Kan.
Garrett, Raymond A., Maywood, N. J.
Gasink, Lewis T., Mora, Minn.
Golding, John, Doncaster, England
Gupta, Jagdish C., Delhi, India
Hastings, Russell, Jr., Battle Creek, Mich.
Henderson, Robert R., Richland, Wash.
Holl, Peter M., Cincinnati, Ohio
Horn, Elford W., Kansas City, Mo.
Hughes, George G., Jr., Shreveport, La.
Husain, Muhammad S., Sheffield, England
Kehoe, Joseph M., Kansas City, Mo.
Kern, Joseph D., Dayton, Ohio
Kirkpatrick, Frank D., Detroit, Mich.
Koberstein, Edward J., Toledo, Ohio
Kortvejesi, John W., Akron, Ohio
Kratz, Edward M., Schenectady, N. Y.
Krause, William G., Morton Grove, Ill.
Krukowski, Boleslaw J., Irvington, N. J.
Lang, Richard B., Concord, Mass.
Leonard, James W., Cincinnati, Ohio
Lively, Beauford C., Charleston, W. Va.
Loud, Edgar R., Cranston, R. I.
Lunsford, Gene B., Pampa, Texas
Maloney, Bernard, Gary, Ind.
Mandry, Wilfred J., London, England
Marbob, Robert F., State College, Pa.
Marvet, Bernard H., Knoxville, Tenn.
McBride, Charles S., Schenectady, N. Y.
McCall, Malcolm M. J., Pittsburgh, Pa.
McCown, J. Bryant, Wewoka, Okla.
McCoy, Robert C., San Francisco, Calif.
McOsker, Charles E., Schenectady, N. Y.
Mayer, Harry H., Jr., Minneapolis, Minn.
Michaels, Franklin, Orrville, Ohio
Mollerus, Fred J., Jr., Richland, Wash.
Munsell, Fred A., Charlotte, N. C.
Murray, William D., Closter, N. J.
Murry, Robert O., Burlington, Iowa
Nowak, Frank J., North Haledon, N. J.
Onoyan, Hrire, Cranston, R. I.
Ottaviani, Andrew L., Lodi, N. J.
Palley, I. Nevin, Dallas, Texas
Pankonin, Earl T., Elmwood Park, Ill.
Papa, Michael T., Bethpage, L. I., N. Y.
Perier, Claude H., Arcadia, Calif.
Perlman, Alfred E., New York, N. Y.
Riley, Clifford D., Birmingham, Ala.
Rogers, Edward W., El Dorado, Ark.
Rosenberg, Herbert J., New York, N. Y.
Rountree, Ray L., Shreveport, La.
Scheer, George B., Berkeley, Calif.
Scott, Frank M., Western Springs, Ill.
Sethi, Raj K., New Delhi, India
Sharangdhar, Taro K., Bombay, India
Shook, Louis L., Jr., Warwick, Va.
Shoupp, William E., Pittsburgh, Pa.
Silkwood, Monzell, El Dorado, Ark.
Smith, Bernard H., Jackson Heights, L. I., N. Y.
Smith, James G., Dallas, Texas
Sousslopp, Dimitri G., Warwick, R. I.
Speca, Elio J., Wellsville, N. Y.
Spiegel, James I., McKeesport, Pa.
Stamper, Eugene, New York, N. Y.
Straub, Robert C., North Augusta, S. C.
Theodorides, Steve K., Kansas City, Mo.
Tracy, Richard J., Providence, R. I.
Trowbridge, Roy P., Detroit, Mich.
Vajda, Stephen, Pittsburgh, Pa.
Valentine, Russell L., Kurham, N. H.
Van Der Heide, Hendrik, Jr., Los Angeles, Calif.
Vanucci, Frank, Newark, Ohio
Veletsos, Anestis S., Urbana, Ill.
Vomaske, Richard F., San Diego, Calif.
Wagner, Jules A., New Milford, N. J.
Weaver, Firm L., Lynn, Mass.
Weller, John L., Old Greenwich, Conn.

Change in Grading

Transfers to Member or Affiliate

Belue, Richard O., Lancaster, S. C.
Bradburn, John E., Elk River, Minn.
Brown, Laurence E., Paramus, N. J.
Buescher, Adolph E., Jr., Kirkwood, Mo.
Cammer, Moses, Brooklyn, N. Y.
Chenoweth, Dean B., Minneapolis, Minn.
Dornbrand, Harry, Wantagh, N. Y.
Du, Darfoon, Flushing, N. Y.
Foster, John S., Chillicothe, Ohio
Frantz, Charles E., Richland, Wash.
Galopin, Frank E., Rio de Janeiro, Brazil
Guillou, John C., Urbana, Ill.
Hodges, John T., Scarsdale, N. Y.
Kirkpatrick, Milton E., Jr., North Augusta, S. C.
Leopold, Wilbur R., Jr., Ridgewood, N. J.
Livingston, Howard S., Landenberg, Pa.
Martin, Jay J., Jr., Cambridge, Mass.
Norton, John H., Newark, Del.
Oakey, William E., Jr., San Antonio, Texas
Osborne, William C., Westfield, N. J.
Osojnak, Boris M., Pittsburgh, Pa.
Packer, Leo S., Buffalo, N. Y.
Peltoniemi, Rudolf E., S. Pasadena, Calif.
Rhodes, Allen F., Houston, Texas
Robbins, Vernon E., Chicago, Ill.
Smith, Willard W., Seattle, Wash.
Stamm, Franklin L., San Gabriel, Calif.
Sullivan, Robert P., Chattanooga, Tenn.
Tint, Lester M., Los Angeles, Calif.
Walsh, John J., Chicago, Ill.
White, William M., Jr., Elkhart, Ind.

Transfers from Student Member to Associate Member.......................................62

Obituaries . . .

William Miles Chatard (1875–1954?), whose death was recently reported to the Society, was retired as manager, district office, American Engineering Co., Baltimore, Md. Born, Baltimore, Md., June 26, 1875. Parents, Ferdinand E. and Josephine (Miles) Chatard. Education, Loyola College, Baltimore; ME, Stevens Institute, 1901 Married Josephine Lee, 1917; daughter, Josephine L. Jun. ASME, 1903; Mem. ASME, 1909.

Howard Arthur Christy (1908–1954?), whose death was recently reported to the Society, was marine engineer, Sperry Gyroscope Co., Great Neck, N. Y. Parents, Otis A. and Laura May Christy. Education, attended Temple University. Married Margaratta M. Mollik, 1946. Jun. ASME, 1939.

Charles Warren Elmes (1872–1954), retired, president, Charles F. Elmes Engineering Works, Chicago, Ill., died April 12, 1954. Born, Buffalo, Iowa, Aug. 28, 1872. Parents, Charles F. and Clara M. (Clark) Elmes. Education, Chicago Manual Training School; ME, Cornell University. Married Virginia Pemberton. Mem. ASME, 1904.

William Fowden (1867–1954), consulting engineer, South Dakota State Cement Plant, Rapid City, S. Dak., died Oct. 17, 1954. Born, Germantown, Pa., Dec. 8, 1867. Parents, Samuel and Sarah (Dempster) Fowden. Education, Philadelphia grade schools; Spring Garden Institute. Married Florence Roach. Married 2nd, Catherine L. Dice, 1939. Mem. ASME, 1913. Survived by wife; daughter, Mrs. Irene K. Wilkerson, Sante Fe, N. Mex.; sister, Mrs. Mary F. Gwilliam, Beachwood, N. J.; and uncle, J. J. Fowden, Philadelphia, Pa.

Benjamin Parker Graves (1884–1954), consultant in design, Machine Tool Division, Brown & Sharpe Manufacturing Co., Providence, R. I., died Nov. 11, 1954. Born, Mansfield, England, Dec. 2, 1884. Parents, John C. and Annie Elizabeth Graves. Education, Rhode Island School of Design, 1904; one year, mechanical engineering, Brown University. Married Elizabeth Robb, 1908; children, E. Marshall, Elizabeth H. He held 27 patents pertaining to machine tools; invented an all electrically operated milling machine and plain grinding machine and omniversal mill machine. Contributed numerous articles to technical journals. Mem. ASME, 1923; Fellow ASME, 1946. He served the Society as a director at large, 1949–1953; chairman, Technical Committee No. 3 on Machine Tapers; Sectional Committee on Standardization of Small Tools and Machine-Tool Elements; member, Advisory Committee, Machine-Design Division; chairman, Committee on Student Talks, Machine-Design Division; member, Committee on Medals for five years; chairman, 1943, Nominating Committee; and member of various technical committees. He held membership in several other professional societies.

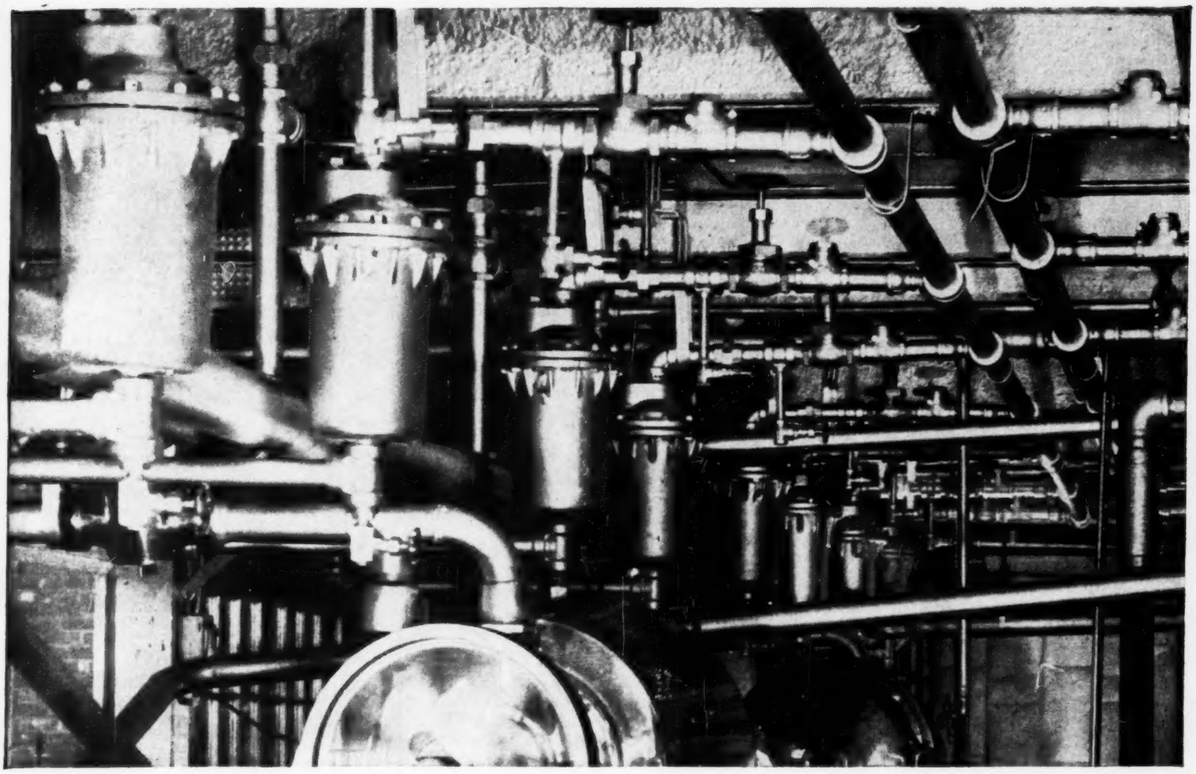
Charles Lewis Griffin (1867–1954), former dean, college of applied science, Syracuse University, and author of textbooks and articles on machine design, died Aug. 9, 1954. Born, Springfield, Mass., Oct. 24, 1867. Parents, George A. and Jane M. Griffin. Education, BS, Worcester Polytechnic Institute, 1888. Married Ida W. Joslyn, 1892. Mem. ASME, 1893. Survived by wife and daughter, Mrs. Florence Wells, Albany, N. Y.

Howliette James Keener (1902–1954), plant engineer, Conmar Products Corp., Newark, N. J., died Oct. 20, 1954. Born, Jersey City, N. J., July 25, 1902. Parents, Mr. and Mrs. George M. Keener. Education, EE, Pratt Institute, 1936. Married Frances Byington, 1923; children, Paul F., Miami, Fla.; James H., Dover, Del. Married 2nd, Frances Peschke, 1950. Jun. ASME, 1935; Mem. ASME, 1947. Author of several papers published in various journals. Survived by wife; two sons.

Paul Frederick Kruger (1884–1954?), whose death was recently reported to the Society, was president, Cia. Salitrera Anglo Lautaro, Santiago, Chile. Born, Milwaukee Co., Wis., May 15, 1884. Parents, John and Mary (Steinbach) Kruger. Education, 2 years, high school; ICS courses. Married, his wife died in 1951; daughter, Mrs. Harriett K. Gilbert. Received All Merito order, comemdador grade, from the Government of Chile in 1938. Mem. ASME, 1922.

Edwin Robert Little (1887–1954), president, B. R. Little Co., Inc., consulting engineers, Detroit, Mich., died Nov. 1, 1954. Born, Norwalk, Ohio, April 24, 1887. Parents, Edwin E. and

(ASME News continued on page 206)



How To Increase Production and Still Use Less Fuel!

Problem—Cooking kettles at National Cranberry Company, South Hanson, Mass., couldn't produce enough to supply three recently speeded up canning lines. There was neither enough space nor steam supply capacity to add more kettles. Might there be another answer?

Solution—Mr. Russell Appling, Production Manager, made a very logical move, with everything to gain and nothing to lose. He called his local Armstrong Representative to talk about re-trapping his set-up. The existing traps were replaced with Armstrong 2" No. 216 large vent traps, one on each of the 8 kettles. Additionally, the steam lines were trapped to assure a dry steam supply.

Results—30% more kettle production. A fourth canning line was added to keep up with output. And, fuel consumption dropped 30% despite the production increase!

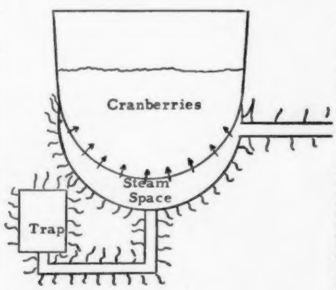
If you want more efficient production, greater return on equipment investment, why not call *your* Armstrong Representative. See your classified phone directory or Thomas Register, or write:

ARMSTRONG MACHINE WORKS
894 Maple Street, Three Rivers, Michigan

Application Engineered **Ask for Steam Trap Book**

ARMSTRONG STEAM TRAPS

HOW A KETTLE CAN GIVE 30% MORE OUTPUT WITH 30% LESS FUEL



Assume that with trap "X", inadequate for the job, cooking time is 10 minutes. During that period heat is radiating (wavy lines) from supply lines, kettle and trap. This non-productive heat loss wastes steam. Now, with an Armstrong trap keeping the steam space free of air and condensate, heat transfer rate is fast and cooking is done in 6 minutes. Thus, four minutes of non-productive radiation loss is eliminated—the faster cooking actually saves steam.

Ella (Collette) Little. Education, 3 years, Denison University; BME, University of Michigan, 1913. Married Eleanor T. Colby, 1916; children, Ellen C., Robert C., Marjorie C. Assoc-Mem. ASME, 1916; Mem. ASME, 1921. Served the Society as member, Executive Committee, Detroit Section, 1933; Reception Committee, 1934–1935. Author of several published technical papers.

Glenn Moore Loomis (1891–1954), chief engineer, Durez Plastics & Chemicals, North Tonawanda, N. Y., died Oct. 16, 1954. Born, Manchester, N. H., Dec. 15, 1891. Education, BS(ME), University of New Hampshire, 1915. Mem. ASME, 1947. Survived by wife, the former Edna Philp, and a daughter, Mrs. Deane F. Flader, East Hempstead, N. Y.

Leon Menzl (1883–1954), retired consulting engineer for sugar industries, died Nov. 29, 1954, at Norwalk Hospital. His home was in Westport, Conn. Born, Long Island City, N. Y., Aug. 19, 1883. Parents, Ardwin J. and Johanna Menzl. Education, graduate, Pratt Institute, 1903. Married Madeline Fitting, 1906. Assoc-Mem. ASME, 1921; Mem. ASME, 1924. He designed major sugar factories in Cuba, Puerto Rico, and South America; and in 1946 was retained to survey and report on the Mexican sugar industry, a project involving 70 mills. Survived by wife and two sons, Leon, Jr., Raymond A.

William Henry Mitchell (1878–1954), mechanical engineer, The Niagara Falls Power Co., Buffalo, N. Y., died March 2, 1954. Born, Pittsburgh, Pa., Feb. 8, 1878. Parents, W. H. and Martha E. Mitchell. Education, ME, University of Pittsburgh, 1901. Married Margaret E. Hays, 1907; children, Mary E., Robert G. Assoc. ASME, 1913; Mem. ASME, 1935.

Ronald Hardy Smith (1932–1954), engineer, Verrier Construction Co., Portland, Me., working in Portsmouth, N. H., died Oct. 28, 1954. Born, Springfield, Mass., Nov. 4, 1932. Parents, James Everett and Helen (Hardy) Smith. Education, BSME, University of Maine, 1954. Married Marcia Hall, 1954. Assoc-Mem. ASME, 1954. Survived by wife; his parents, and a brother, James E., Jr.

Alfred Edward Sorenson, Jr. (1929–1954), designing and testing of electronic equipment, Applied Science Corporation of Princeton, died Sept. 25, 1954. Born, Princeton, N. J., Dec. 5, 1929. Parents, Alfred E. and Emily Margaret Sorenson. Education, Hun School, 1948; BSE (ME), Princeton University, 1952. Married Patricia Ann Wiesner, 1953. Jun. ASME, 1952. Survived by wife; his parents; and two brothers, George and Robert.

Richard Van Arsdale Sutherland (1904–1954), chief engineer, National Tank and Manufacturing Co., Los Angeles, Calif., died Nov. 13, 1954. Born, Wilmette, Ill., Nov. 6, 1904. Parents, George R. and Ida Belle (Redeker) Sutherland. Education, Kemper Military School; Washington University. Married Eleanor Given Thompson, 1933; daughter, Ann. Author of several technical papers published in various professional journals. Mem. ASME, 1936.

Frederick von Schlegell (1874–1954?), whose death was recently reported to the Society, was former president, United Linen Supply Co., Los Angeles, Calif. Born, St. Louis, Mo., Jan. 27, 1874. Parents, Frederick and Marie (Muller) von Schlegell. Education, BEE, University of Minnesota, 1895. Married Edna Glover, 1903; son, Frederick, Jr. Mem. ASME, 1915.

Robert Everett Walsh (1894–1954), product and service manager, Orange and Rockland Electric Co., Monroe, N. Y., died Oct. 27, 1954. Born, Newark, N. J., July 18, 1894. Parents, Robert E. and Jessie F. Walsh. Education, Newark (N. J.) public schools and Newark Academy. Married Elsie Noble, 1916 (died 1939). Married 2nd, Martha Lipscomb, 1942. Mem. ASME, 1943. He was well known in the power-plant industry and the operation of groups or systems of power plants. Survived by wife; daughter, Mrs. Winston O. Burgess; son, Lt. Robert E. Walsh, USCG; his mother; brother, Capt. Herbert E. Walsh, USCG; and five grandchildren.

Robert Bunsen Wolf (1877–1954), paper-company industrialist, management consultant, and engineer, died Nov. 11, 1954. His home was in New Canaan, Conn. Born, Newark, Del., May 16, 1877. Parents, Theodore R. and Rose (Kohler) Wolf. Education, BEE, University of Delaware, 1896; ME, 1916. Married Harriette Curtis Cooch, 1900. Mem. ASME, 1913; Fellow ASME, 1936. He served the Society as vice-president, 1920–1922. He held more than 20 United States and foreign patents pertaining to pulp and paper-mill design. He received the Frederick W. Taylor Key from the Society for the Advancement of Management in 1946. For many years he was director of the National Bureau of Economic Research. Author of many technical articles published in trade and professional journals. Survived by wife; two daughters, Anne Wolf, Mrs. Frederick Woolverton; and two sons, Theodore, Robert B., Jr.

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From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information, you should be registered in the Divisions (no more than three) in which you are interested. Your membership card bears key letters opposite your address which indicate the Divisions in which you are registered. Consult the form on this page for the meaning of the letters. If you wish to change the Divisions in which you are registered, please notify the Secretary's office.

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